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ISSUES IN NASA PROGRAM AND PROJECT MANAGEMENT

Special Report: 1993 Conference

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Special Report: 1993 Conference

edited by

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Issues in NASA Program and Project Management

A Collection of Papers on Aerospace Management Issues
from the Program/Project Management Conference, April 20-23, 1993

National Aeronautics and Space Administration **Autumn 1993**

SP-6101 (07) Issues in NASA Program and Project Management is seventh in a series from NASA's Program and Project Management Initiative. This series is collected and edited by Francis T. Hoban with Dr. William M. Lawbaugh. Statements and opinions are those of the authors and do not represent official policy of NASA or the U.S. Government. Useful and enlightening material is welcome, and diversity of ideas is encouraged.

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Perspectives in Program and Project Management

by Dr. Edward J. Hoffman
PPMI Program Manager

NASA's Program/Project Management Initiative was pleased to sponsor this conference. The timing for this conference in many ways could not have been better. NASA has taken off on a course that is leading to major changes in our programs and in the very way we manage our projects. From redesigning the Space Station to inquiry into how projects are to be managed, we are witnessing a time of tremendous change in project management.

In the last year alone, we have seen the genesis of numerous studies and activities to help define the future of NASA. The NASA strategic planning committee has been looking to define the future missions as well as the roles and responsibilities within the Agency. In separate but related activity, much scrutiny is being given to better defining project management at NASA and establishing a new NMI. Several activities have led to recommendations, aimed at reducing the costs and time in our programs, which will have far-reaching effects on project management. In addition, much has taken place over the last year in the areas of systems engineering, program control and procurement that will influence how projects are managed, and how we will be training future members of the project team.

The rapidity of change that we see today is likely to be just as rapid tomorrow. Peter Vaill has used the metaphor of white water rafting to describe what managers must be prepared to handle; his term seems to aptly capture the challenges of project management today. It was hoped that this conference would better enable us to deal with some of the changes and challenges that we face today. During the three days in Hagerstown, many of the key issues in project management were discussed. We tried to put together a conference where members of the NASA family, other agencies and industry could freely discuss these issues.

The individuals who agreed to serve as speakers and panel members are an impressive array of people. I am sure that you will find many of the ideas expressed to be quite stimulating and even provocative.

I read where Einstein would try "thought experiments," visualizing himself in a circumstance which was improbable in order to generate practical ideas. This conference summary is also intended to lead to your own "thought experiments" pertaining to NASA and project management.

I am sure many of the ideas and presentations will reinforce your own views. I am also sure that many of the ideas will force you outside the boundaries of what you consider sensible, based upon your own experience. It is hoped that this document will reinforce some of the knowledge you have as well as provide you the opportunity to form new ideas about project management.

This document is, by no means, a complete transcript of the three-day conference in April 1993. Rather, this is a representative sampling of some of the newest ideas in NASA on program and project management. Every effort has been made to avoid duplicate ideas and comments, and so not all speakers and panelists are included. What remains is for your enjoyment and edification.

Dr. Edward J. Hoffman is the NASA Program/Project Management Initiative Program Manager. In this role he is responsible for training and development programs, consulting services for project management teams, lessons learned, knowledge capture, and research and special studies on program and project management.

The Best Job in Aerospace

by A. Thomas Young
Martin Marietta Corporation

The program/project manager's job is, in my opinion, the best job in the aerospace universe. Whether one is working at NASA or in a private company, the program manager's job is often filled with frustration, stress, and risk-taking, but it offers opportunities and rewards unavailable anywhere else. Being a program manager means integrating a variety of disciplines–such as science, engineering, planning, finance, human resources, etc.–to accomplish an important goal, and really making a difference and seeing the result of your work. In short, program management is "being where the action is" in the development and application of exciting new technologies and processes.

The principles of successful program management are no secret, but they bear reiteration from time to time to remind us of the complexity of the program manager's job. In my view, there are seven key steps:

- **Pick the best people.** Getting the right people on your team, then putting them in the right slots, is what separates successful projects from also-rans. But selection is only the first part of the process. Then you have to train your people properly, give them the right tools, "empower" them to do jobs, and support them in their decisions.

- **Instill attention to detail.** Projects rarely fail because of large flaws. Usually, it's overlooking the seemingly small details that dooms otherwise sound programs.

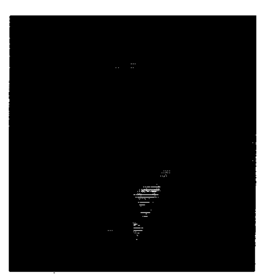
- **Build in adequate reserves.** "Redundancy" has been a mandate since the early days of the manned space program, for good reason–repair shops are few and far between in space. Working in experimental programs such as NASA's requires having adequate margins, whether they be in funding, scheduling, computing capacity, spacecraft performance, and so on.

- **Design according to technical requirements.** While every project begins with a technical need, political considerations soon tempt project managers to weave in other factors. To avoid such influences, you must build an inviolate shield around your project, insulating it against outside forces.

- **Avoid fixed-price contracts.** Space exploration is still an experimental and highly uncertain undertaking. Recognizing this, managers of NASA projects should accept the notion that fixed-price contracts are inherently out of place when one is pushing the boundaries of technology. This is a controversial concept in today's budget climate, and I would never defend bad management by a contractor. But the alternative philosophy–i.e., trying to eliminate risk altogether–could, over time, effectively destroy NASA's willingness to take risks.

- **Involve the user.** The emphasis in project management is on integrating representatives from both inside and outside the organization. Involving the customer at each step of the project makes him or her a contributor and proponent, not a distant, and often critical, observer.

- **Put quality first.** This management tool has long graduated from "buzzword" status to become one of the most potent techniques a leader has to build in performance at each step of the project. Quality cannot be "balanced" with other variables; it must be put first. If it is, then cost and scheduling will certainly fall into place.



A. Thomas Young is President and Chief Operating Officer of Martin Marietta Corporation in Bethesda, Maryland. He joined Martin Marietta in 1982 after a 21-year career at NASA, where he served as director of the Goddard Space Flight Center. Prior to 1980 he was deputy director of the Ames Research Center.

Improvements in Project Management at NASA

Presented by William C. Huber
Assistant Director of Program Development, Marshall Space Flight Center

In the summer of 1992, the NASA Administrator asked Marshall Space Flight Center Director Jack Lee to chair an Agency-wide team to conduct a six-month review of 30 recent NASA projects. The team found eight major factors that drive NASA program cost and technical increases inadequate Phase B definition, unrealistic dependence on unproved technology, annual funding instability, complex organizational structures, cost estimates that are often misused, scope additions due to "requirements creep," schedule slips, and an acquisition strategy that does not encourage cost containment.

The fact that similar findings appear in earlier NASA studies indicates that NASA may not have learned fully from past reports, as illustrated in the "Common Issues" matrix on the next page. Many of the dozen recommendations of the Program/Project Institutional Team have also appeared in earlier studies:

1. Establish a Program Management Council (PMC) to review, rank and recommend all subsequent Phase B studies and Phase C/D program starts.

2. Establish an Agency-level funding wedge for these same studies and starts.

3. Direct program/project managers to define requirements better. Planning should carry Phase B at least through PRR or PDR before Phase C/D starts.

4. Provide stable funding for high priority NASA programs by multi-year funding or by internal protection.

5. Use performance specifications instead of detailed design specs in new starts where possible.

6. Comply with Phase C/D "period of understanding" on time-phased contractor buildup (NMI 7120.3).

7. Freeze requirements at the end of the "period of understanding." Resist easy changes.

8. Appoint project manager and key team members at beginning of Phase B and keep them into Phase C/D if possible.

9. Allocate adequate contingency reserves (NMI 7120.3) for project managers but hold the Allowance for Program Adjustment (APA) at Headquarters for scope changes and major problems.

10. Promulgate progressive competition/down selection procedure to minimize gaps between program phases.

11. Provide comments to Code H, NASA Headquarters, on "Award Fee Initiatives" for cost containment.

12. Avoid "buy-in" by requiring cost estimates, by providing project funding profile to prospective contractors for Phase C/D, and by emphasizing the scoring of cost realism in the source selection process.

While some of the recommendations have been proposed for many years, the Administrator has accepted them and handed them off to the Program Excellence Team chaired by Howard Robins. The team has prepared a new NMI, currently in the review cycle, based upon these recommendations.

Common Issues Matrix

Issues	1975 PM Workshops	1978 SEP	1980 PM Colloquium	1981 Hearth Study	1982 PM Colloquium	1985 SEP	1986 SEP	1986 NASA Cost Studies	1986 (Phillips) Review of SS	1986 (Phillips) NASA Mgmt. Study Group	1987 P² Steering Group	1987 (Ride) Leadership	1988 (Phillips) HQ Mgmt. Study	1989 (Cohen) 90-Day Study	1989 (NAPA) Program Control	1990 (Augustine) Future of U.S. Space	1991 Executive PM Colloquium	1991 APM Follow-on
Conduct Training for Program/Project Management	√		√					√		√	√				√		√	√
Conduct Annual Meeting of Project Managers	√																	
Develop Realistic Cost Estimates	√		√					√		√					√	√	√	
Clarify HQ Role in Project Management	√		√			√			√	√	√					√	√	√
Improve Adequate Front End Planning Definition	√	√	√	√	√	√		√									√	
Need for Long Range Vision and Agency Goals										√	√	√	√			√	√	√
Conflict Between Institutional and Program Needs										√	√		√					
Attention to Operations and Logistics										√	√			√				
Need for Adequate Requirement Definitions	√	√		√	√	√			√							√		
Contractor and NASA Buy-ins		√		√	√										√	√	√	√
Clarity and Communication of Mission Goals and Objectives	√	√		√	√		√			√		√	√			√	√	√
Need for Communication at All NASA Levels and Contractor Teamwork	√	√	√	√	√	√	√						√				√	√
Improve Management of Contingency Funding	√		√	√		√								√		√		√
Eroding In-house Technical Expertise			√	√							√			√		√	√	√
Need for Risk Assessments	√			√	√	√	√	√			√						√	
Increasing Technical Complexity of Projects				√		√							√	√		√		
Develop Formal Top-Down Planning Process			√							√		√	√		√		√	√
Formalize S/E Process								√		√			√				√	
Maintain More Consistent Documentation								√		√			√					
Better Manage Congressional Issues										√								
Over-commitment			√								√					√	√	
Need to Establish Improved International Involvement									√		√			√				
Improve Program Control Function—Develop Agency Models, Control to Baseline, etc.				√						√			√	√	√			√
Acquisition Reform													√	√				√

Planning the Project

Presented by William C. Huber
Assistant Director of Program Development, Marshall Space Flight Center

In brief, Bill Huber says, "the project manager's job is to deliver a successful product on time and within budget." To do that requires careful, thorough planning. Following on the results of the recent Project Planning Institutional Team, Huber notes that "best studies have shown a strong correlation between the percentage of the project cost spent in the definition/planning phase and the amount of cost overrun realized during the development. It is recommended that 10 to 15 percent of the project costs should be spent during Phase B."

Huber listed ten criteria for good Phase B planning:

- Adequate funding
- Advanced development activities in critical areas
- Key personnel assigned in Phase B and carried in Phase C/D
- A strong project team with good technical support
- The elimination of all TBDs (To Be Determined)
- Performance of adequate risk assessment (both technical and programmatic)
- Development of a usable Work Breakdown Structure (WBS)
- At least one, good, objective, non-advocate review
- A good Phase A study as a beginning base
- A well defined set of products
  - Documented set of products
  - Baseline/reference system and operational description
  - Definition of all external interfaces
  - Detailed life cycle costs
  - Detailed schedule with known critical path
  - Updated acquisition plan
  - Request for proposal for Phase C/D

Realizing that a project manager may not have all ten criteria satisfied, Huber gave his thoughts of what a project manager "should" do to deliver a successful product. Many of these suggestions are what should be "common sense," but many also require some discipline and know-how to turn the tide when any of the ten criteria are not present or lacking in some way:

- Unrealistic dependence on unproven technology
  - Assess the technology requirements vs. readiness
  - Define alternative approaches to the project and their impacts
  - Plan an advanced development program so that all technology is proven during Phase B
  - Carry alternative approaches until technology is proven
  - Establish decision points in Phase B where alternative can be dropped or accepted
- Complex organizational structures or multiple/unclear interfaces
  - Determine in Phase A what other organizations are essential to a successful project (e.g., HQ, other Centers, international, science working groups, other agencies)
  - Keep structure/involvement as simple as possible
  - Obtain approval of outside involvement early
  - Select and define instruments as early as possible
  - Attempt to define all external interfaces in parallel with project definition
  - Eliminate TBDs
  - Keep ample margins in interfaces
- Scope additions due to requirements creep
  - Don't add "nice to have" changes (just say no)
  - Thoroughly understand "make work" changes *before* authorizing
  - Assure adequate budget and schedule *before* accepting program-level directed changes
  - Keep contract specifications at "requirements level" rather than "design level" to minimize changes
  - During Phase B, thoroughly understand and document the requirements
- Schedule slips
  - Understand the relationship between time and money
  - Understand the detailed schedule and the critical path(s) so as to define workarounds and other alternatives
  - In Phase B, develop detailed schedule and cost estimates, conduct programmatic and technical risk analysis

The project manager, Huber adds, is the one responsible for proper planning. "A poor plan is almost impossible to implement."

Strategic Planning . . .
Mapping the Way to NASA's Future

Presented by Dr. Charles J. Pellerin Jr.
Deputy Associate Administrator for Strategic Planning

"We have plans," said Pellerin, "what we lack is strategic management" which is so vital for an agency bereft of a mandate as clear as the one set by President Kennedy. Pellerin described himself as a "Process Manager" as opposed to a project manager.

Strategic planning efforts began in earnest January 6, 1993, when the Senior Management Group (NASA Administrator, Associate Administrators and Center Directors) decided on an overall strategic planning process and agreed on a plan development method. Besides some basic assumptions, such as 5 percent growth in FY93 and a historical balance of 80 percent for human piloted and 20 percent for robotics exploration program funding, the group agreed to a mix of small, medium and large space service missions. They agreed to link aeronautics and space technology to economic competitiveness, and to limit "Mission to Planet Earth" to a "go as you pay" basis.

From a field perspective, a Strategic Planning Red Team found no single centerpiece that represents what NASA does. Rather, "we are a diverse conglomerate," says Pellerin, in need of strategic planning as a managerial leadership process. Pellerin's assessment of NASA's traditional "Strategic Purposes" follows:

"We boldly expand frontiers in air and space to:

- Provide inspiration and hope for the future.
- Contribute to world peace.
- Enhance economic growth and competitiveness.
- Understand and help preserve the environment.
- Support broad national social goals.
- Maintain a high-tech industrial base."

As for the first purpose, Pellerin jokingly noted a survey which showed that school kids were most interested in "space, dinosaurs and ghosts," placing this industry in the company of the dead and the extinct. The second purpose points to a foreign policy factor in the founding of NASA, but the space race is over and the Russian space program is no longer perceived as a threat. The third purpose reflects some perception in Congress that NASA is a "jobs program," but that purpose wanes with 124 new members–new members of Congress focus more on constituent needs than support for NASA. The fourth purpose is laudable, he notes, but EOS has had a shaky start and stockholder support is uneven. The fifth purpose has been a low priority for NASA and has been recognized as weak. Finally, the last stated strategic purpose may be a high priority for scientists, CEOs, trade association heads and Congressional committee heads, but they may tend naturally to defend the status quo because it protects their interests. Frequently, however, these leaders have their own agendas and work at cross purposes to each other and to NASA.

So what is NASA to do? Unify around a program like human exploration of the Moon and Mars? Unify around a role like America's technological leadership? Or shall we find some other "glue" for NASA, to mobilize and inspire the entire agency, to convince the political system and the public, and to create a "tangible" image?

The first step, according to Pellerin, is to listen to what others say, think and feel. On February 17,1993, space policy analysts and professional staff members briefed the Senior Management Group and told NASA that Congress has little motivation to find "inspiration" in these troubled times, that NASA may have less relevance to the national agenda and that NASA needs to improve its "tangible" benefits. While NASA may be supported because of an ongoing "jobs program," the agency's actions are perceived as going against U.S. competitiveness. External analysts say that only NASA perceives education as a central role of the agency.

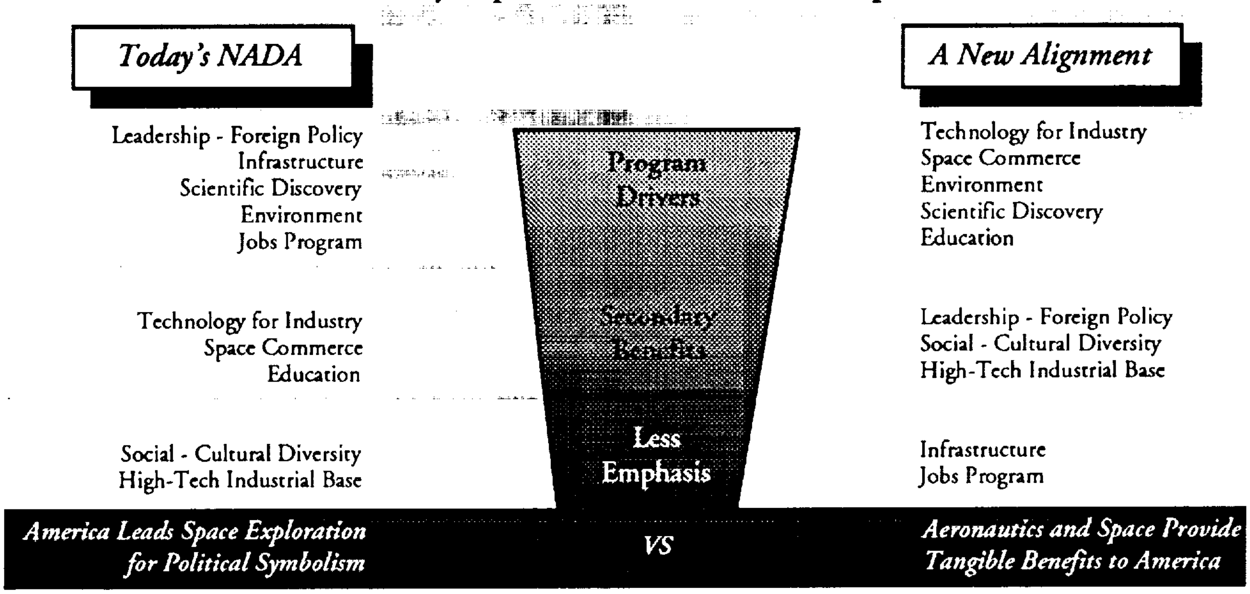
Internally, Pellerin described the work of the NASA Employee Vision Team, which involved about 7,000 employees (22 percent) in one way or another. Working by consensus, the team found a growing recognition by employees that NASA must be relevant to America's needs. The meaning and value of "exploration" was the most difficult issue; is it a means to an end or an end itself? Should we then stress concrete benefits or the intangibles such as hope, inspiration and pride? Their consensus: "Explore the universe to enrich human life by stimulating human curiosity, opening new worlds of opportunity, and uniting nations of the world in this quest." The common perception that only humans explore and that robots gather scientific data tends to cause rifts between Centers, but the emergent consensus reads: "Both humans and robots contribute to 'expanding frontiers,' and both should be integrated into programs." Aeronautics, also, was recognized as important to all NASA installations. "The NASA Vision" thus includes exploration, science, and aeronautics, but directed to four national goals for economic growth, preserving the environment, educational excellence and peaceful exploration.

In March 1993 the group studied the Vision Team findings plus the results of six NASA Town Meetings held across the country in November and December. The results were consistent across the country: the majority of citizens were not satisfied with the NASA employee vision, finding it not bold or specific enough, claiming it lacked emphasis on exploration and space settlement. The primary concern expressed in each of the NASA Town Meetings, involving more than 4,500 people, was: improve communication with the public. Other concerns, in order of importance, were: to make space transportation safer at lower cost, to do more to support teachers and students, and to improve both technology transfer and R&D efforts.

A new framework of "shareholders" or "customers" was formed from those efforts. From this perspective, new alignments of programs were proposed. Instead of program drivers like space exploration for purposes of political symbolism, the new NASA may well concentrate on the immediate economic impact on key industries, technology transfer and spinoffs, and large-scale space-based commerce, Pellerin suggested. Instead of the intangibles of inspiration or of exploration as an end in itself, the new NASA might do well to emphasize the tangible benefits of technological leadership, scientific discoveries, international participation, environmental monitoring and analysis, and educational outreach.

The details for a new "shared vision" are still being worked out, according to Pellerin, but they cluster around four interrelated hosts or "missions":

We boldly expand frontiers in air and space . . .



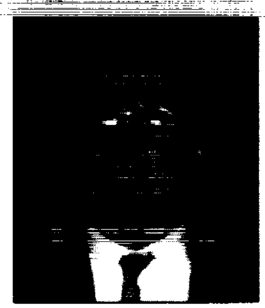
- Mission for Space Development
  - Develop the basis for large-scale, space-based commerce
  - Provide the capability for long-duration human and machine operation in space
  - Develop and transfer technology to U.S. industry
- Mission for Scientific Research
  - Basic Scientific Research
  - Develop and transfer technology to U.S. industry
- Mission for Planet Earth
  - Provide environmental basis for sustainable economic growth
  - Develop and transfer technology to U.S. industry
- Mission for Aeronautics and Space Industry
  - Maintain U.S. leadership in existing aeronautics and space industries
  - Develop new capabilities and industries for future space-based commerce

The accompanying functional capabilities were also critical to the strategic planning process thus addressed as part of the plan:

- Access to Space
  - Develop strategies for assuring access to space
  - Assess the state of technology and identify key areas for investment
- Quality Assurance
  - Develop strategy for efficient development of high quality, safe programs
  - Develop and transfer quality assurance expertise to U.S. industry
- Operations
  - Develop strategies to optimize operations across the Agency
  - Develop and transfer operational expertise to U.S. industry
- Technology
  - Develop strategies for technology development to support NASA missions
  - Identify key areas for investment both internally and externally
- Institutional Development
  - Develop strategies for managing and changing the institution

The next steps will require the Senior Management Group to continue the Strategic Planning Process, establish teams to develop appropriate analyses and metrics, and have HQ offices analyze program re-alignments.

(The final outcome and implementation of the Strategic Planning activities is not clear at this time due to Dr. Pellerin's sabbatical, and the impact of Vice President Gore's National Performance Review activities. Efforts are being made to continue this work and formulate a preliminary plan.)



Dr. Charles J. Pellerin Jr. is the NASA Associate Deputy Administrator for Strategic Planning. He is responsible for developing NASA's vision and defining the path, including resource allocation. In 1992 Dr. Pellerin became Deputy Associate Administrator for the Office of Safety and Mission Quality at the request of the NASA Administrator.

Program Excellence

Presented by Dr .C. Howard Robins Jr.
Deputy Associate Assistant Administrator

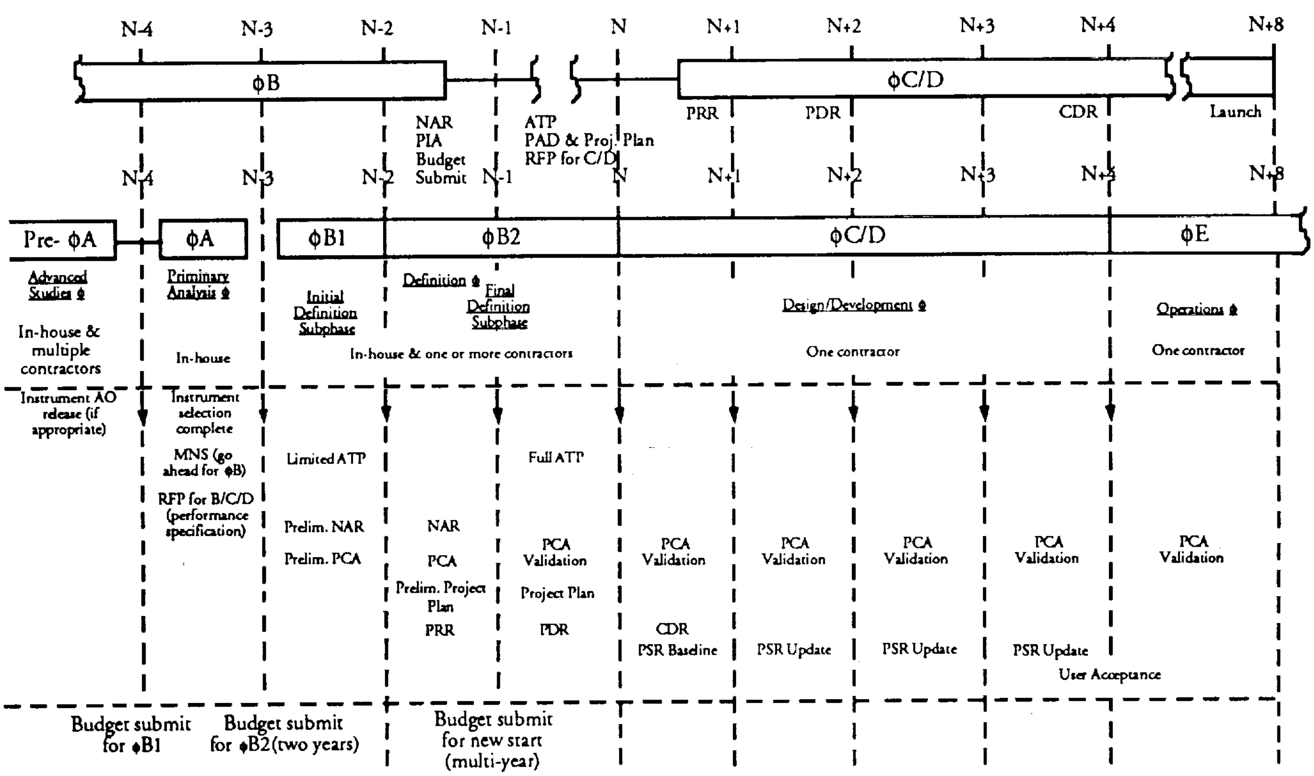
An update of the ongoing effort to strengthen and streamline the policies and the processes of program/project management in NASA was presented by Howard Robins, the team leader for the Program Excellence Team (PET), currently rewriting NASA NMIs on program management.

Robins pointed to factors identified for at least the last 15 years that lead to poor management. These include: new starts that exceeded available resources, inadequate definition, contractor and NASA "buy-in," and failure and/or inability to control to a defined baseline. He noted that current median cost growth for NASA projects is 37 percent (average of 63 percent) and median schedule growth is 40 percent (average of 63 percent), while the nominal length of major projects is 12 years. The PET proposes to shorten life-cycle time and enhance delivery of performance on schedule and within budget.

To accomplish this, the team proposes change in the policies and processes of project management. The end product will be a consolidated NMI replacing three previous ones on project management, acquisition, and the Program Approval Document (PAD). Replacing the PAD will be the PCA (Program Commitment Agreement). New start approval will require not only a formal commitment to deliverables, schedule and budget (the PCA process), but also a requirement showing compatibility with the Agency strategic plan.

Preliminary design is being moved from Phase C to Phase B, and Phase B (definition) initiation approval will have to come from the Deputy Administrator rather than the Program Associate Administrator. The design/cost basis is also changed, from "development" to "life cycle." Agency-level go-ahead approval reviews will be established for Phase B and Phase C/D. These proposals for change are "better" because they will

Nominal Life Cycle For Major NASA Projects (By Fiscal Year)

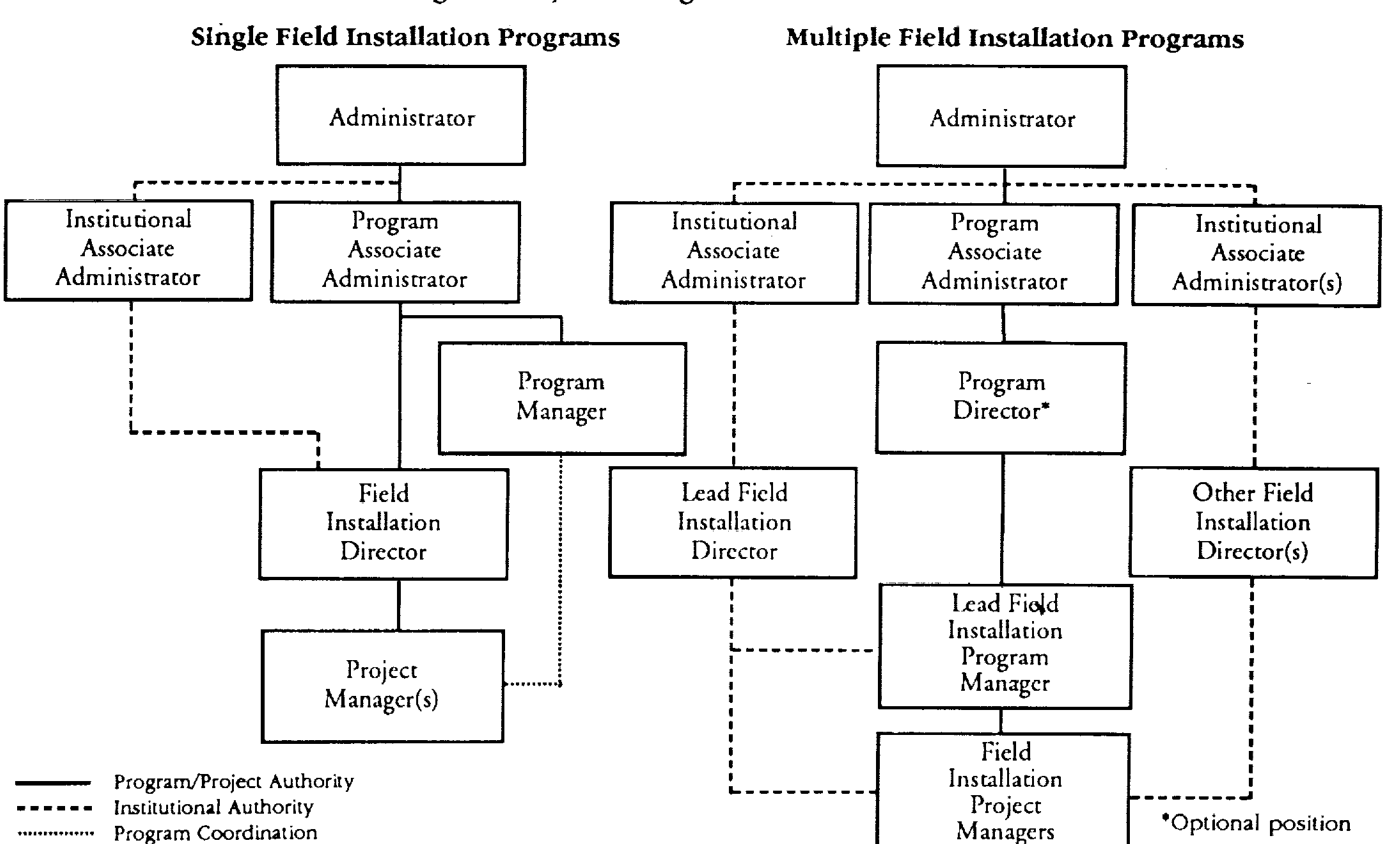


reduce or eliminate the number of premature Phase B starts, establish program commitment as a two way process, as well as several other benefits. Phase C/D (design/development) time will be shortened by about four years, making the project "faster." The project should be "cheaper" because of less time in development through better definitions, a down- select acquisition process and improved cost control.

Robins noted that several issues remain unresolved for OMB/Congress, contractors, and the Agency, involving major cultural change, but adoption of the new policy and process can lead to aggressive, high-visibility improvement in NASA program/project management. Next steps for the Program Excellence Team include a complete review of proposals with senior management, completion of the NMI process, and then the enormous task of institutionalizing the whole process.

Dr. C. Howard Robins Jr. began his NASA career more than 30 years ago at the Langley Research Center. In 1984 he was appointed Deputy Associate Administrator for Management. He was promoted to Associate Administrator for Management in January 1989 and was appointed to his current position as Deputy Associate Administrator for Space Systems Development in October 1991.

Program/Project Management Chain of Command



New NASA Procurement Initiatives

by Deidre A. Lee
Associate Administrator for Procurement

Deidre Lee had previously served as a member of the Space Exploration Initiative's Synthesis Group and helped coordinate the Agency's Red/Blue Team studies to reduce out-year costs of major space and aeronautics projects without undermining mission objectives. Lee described eight procurement initiatives as of April 1993 and gave contact names and phone numbers to the delegates and dinner guests:

Award Fee Initiative. A comprehensive review of award fee contracting at NASA has been conducted. Draft policy will be published in the Federal Register. Key elements of the policy include: emphasis on selection of contract type, use of base fee, role of cost control in evaluations, performance incentives on hardware contracts, a final comprehensive rating, and uniform scoring procedures. Public comments are being reviewed and changes made as appropriate. Point of Contact is Mr. T. Luedtke (202) 358-0003.

Contractor Liability Requirements. Contractors' liability for loss or damage to Government property or correction of failures to comply with requirements of the contract under cost-type contracts is currently severely limited. Contractors are only liable in those cases in which a loss is attributed to fraud, willful misconduct, or lack of good faith at high management levels within the company. Unless such situations can be shown to exist, the Government assumes liability for loss and pays the cost (not fee) of repairing or redoing the effort. A number of options have been examined with the Office of Federal Procurement Policy and Industry to determine if an equitable, effective solution can be developed to place greater responsibility on contractors. The conceptual parameters, upon which a contract clause will be based, were published in the *Federal Register* on March 30,1993. (A report to Congress was sent in June 1993. The final rule and implementation are expected in November 1993.) Point of contact is Mr. T. Deback (202) 358-0431.

Contractor Metrics. NASA is currently implementing the contractor metrics initiative which will allow NASA and contractor senior management to monitor in-process contractor performance. The metrics will have two products: a semi-annual report card to be sent to the contractor's Chief Executive Officer giving notice as to how the contractor is performing, and a set of charts (primarily "run" or trend charts) which will be updated quarterly and/or semi-annually. The metric areas are: cost, schedule, technical, award fee, subcontracting plan, project manager's assessment, and continual improvement. The metrics have been applied to 30 selected contracts, reflecting approximately 60 percent of NASA's 1993 commercial business obligations. The contractor metrics initiative will not require any changes to the contracts or regulations, but will use data already being collected. NASA Headquarters Program Offices have completed their reviews of the metrics submissions and provided their inputs to the Office of Procurement. (The first set of metrics reports were sent out July 30, 1993.) Point of contact is Mr. K. Sateriale (202) 358-0491.

Change Order Reduction/Process Change. In an effort to manage contract changes more effectively and control cost growth, NASA has implemented several initiatives to dramatically reduce the Agency's volume of outstanding unpriced change orders. First, increased Headquarters oversight and reporting requirements have resulted in significant reduction in the number of Center change orders remaining unpriced for protracted periods of time. Second, Procurement has empowered Center technical and procurement personnel to employ Total Quality Management principles to revamp Center policies that impede their ability to manage change effectively and price them in a timely manner. Finally, the Headquarter's offices of Space Flight and Procurement are working jointly to implement policies at our major Centers to ensure change orders are issued on a strict exception basis and limit NASA's cost liability to only the Agency's most urgent requirements.

A revision of the NASA Federal Acquisition Regulation (FAR) Supplement that will implement this policy NASA-wide is expected in October 1993. Collectively these measures should improve the overall change order management and ensure that any change orders issued are characterized by solid technical definition, realistic cost estimates, and markedly improved definitization timeliness. Point of contact is Mr. R. Wilson (202) 358-0486.

COTR Training. It has been documented through internal and external audit and management review that the amount and quality of Contracting Officer's Technical Representative (COTR) training is inconsistent within NASA. This may be a contributing factor to significant deficiencies in the management of both Government prime contracts and subcontracts. This initiative shall identify core mandatory training areas to be implemented by individual NASA installations. NASA FAR Supplement coverage on the required subject matter to be covered in this training will be published by December 31, 1993. Point of contact is Mr. K. Sateriale (202) 358-0491.

Mid-Range Procurement Procedure (Pilot Test Program) NASA has developed a new simplified procurement procedure aimed at a third category of procurement (between small purchase and large Agency acquisitions). The small purchase procedures were used as the basis, adding only those additional provisions necessary for procurements ranging from $25,000 to $500,000 (annually). NASA has proposed this Mid-range Procurement Procedure to OFPP as a Pilot Program under the innovative procurement initiative. The OFPP has formally approved the program with the exception of the electronic bulletin board which requires Congressional approval. The OFPP is currently seeking this approval. Marshall Space Flight Center has been selected as the test site and is implementing this procedure. Full implementation is expected in December 1993. Point of contact is Mr. T. Deback (202) 358-0431.

NASA/Industry Process Action Team (PAT). A NASA/Industry PAT has been formed as an operational working group whose primary function is to identify real-time, procurement-related issues that hinder the effectiveness and efficiency of the acquisition process. The PAT is part of a continuous program to bring about improvement in the procurement process. The team will support biennial NASA/Industry Conferences by developing conference topics and ensuring publication and follow-up on post-conference issues. Membership in the PAT is limited to one year and will be rotated among interested aerospace contractors and NASA procurement representatives. (The NASA/Industry PAT second-year membership of 27 members held its first meeting on May 7, 1993, with the next meeting scheduled for mid-July.) Point of contact is Mr. D. Muzio (202) 358-0432.

Small Disadvantaged Business Goal. Congress has challenged NASA to award eight percent of its appropriations to Small Disadvantage Business; the goal is to meet the eight percent level by FY94. To accomplish this goal, NASA's Office of Small and Disadvantaged Business Utilization (K) and the Office of Procurement (H) have joined together to re-energize focus on small disadvantaged business contracting and subcontracting. Clarified Center and contractor reporting, greater emphasis on subcontracting, and mandatory goals are all aspects of the initiative. On December 1, 1992, the Administrator executed a Determinations and Findings exercise, setting aside more than $300 million in procurement for the SDBs. The Office of the General Counsel in currently seeking legislation which will grant NASA the authority to set aside procurements for SDBs. Point of contact is Ms. D. O'Neill (202) 358-0428.

Ms. Deidre A. Lee was named Associate Administrator for procurement on March 11, 1993. She has been acting in that position since early January and had been Deputy Associate Administrator for procurement since September 1992. Ms. Lee has been with NASA since July 1984. She has an extensive background in a variety of military and government procurement positions.

Segment: The Cost Control Process

During this major topic set, the conference program shifted from larger, Agency-wide overviews and updates to issues key to program and project managers. The Cost Control Process was divided into the four primary segments of Setting Requirements, Planning the Project, Estimating Costs, and finally Controlling Costs. Following these plenary sessions, panel sessions on the same topics were held to allow participant interaction and more discussion.

Setting Program Requirements

Presented by Mark Craig
Space Station Project Office, Johnson Space Center

Based upon his experience, Craig offered four suggestions. First, the entire program team, NASA and contractors, needs to know requirement "goodness" and "badness." Criteria for the former include requirements which are absolutely essential, clear, concise and unambiguous, qualifiable, verifiable, feasible, consistent with all other requirements, representing one thought, hierarchical and traceable.

Requirement "badness" has several attributes, including over-specification, TBDs and negative statements which state that something will not be developed.

Secondly, Craig called for NASA to certify requirement writers through course work and perhaps apprenticeship. Thirdly, "Mandate a sequenced approach to requirement development." Begin with a list of parameters to be controlled, then develop requirements in "bullet chart" format, and then convert requirements to text. Fourth, Craig advises a continuing structural analysis of both customer and system requirements, with particular attention to hierarchical "parents" of proposed requirements to control "requirements creep."

Craig also discussed Concurrent Engineering (CE) as a state-of-the-art approach for creating an effective environment in which to generate requirements. Craig's "10+1 Commandments" of CE:

- Create multi-disciplinary, collocated teams organized by end item
- Emphasize communication, especially with the customer
- Involve contractors early
- Design support processes concurrently
- Integrate technical reviews
- Create a digital end-item model (common data base) (eliminates duplicate effort and gives each team member access to current information)
- Integrate computer-aided engineering tools with digital end-item model
- Simulate end-item performance
- Simulate manufacturing processes (if appropriate)
- Incorporate lessons learned on previous projects
- Improve process continually

"Concurrent engineering works; its principles are fundamentally sound," Craig says, "We should begin now to make the investment to capture its advantages."

Major Issues of Program Management Related to Cost Estimation Practices

by Dr. Humboldt C. Mandell Jr.
Explorations Programs Office, Johnson Space Center

It is believed by many today that human exploration of the solar system is one of the few missions which makes NASA unique among government agencies. Today that mission is severely threatened. It is almost universally believed that such missions are not affordable, and that the U.S. must wait to resume exploration. Budgetary pressures, coupled with the very high costs of human space missions, have created the strong perception that it will be many years before the U.S. can afford to pursue the exploration of the planet Mars, the Moon, and other extraterrestrial bodies.

This set of perceptions has been largely self-created by NASA. It is true that substantial increases in the NASA budget are very unlikely in the foreseeable future. It is also true that human space missions are today extremely expensive, particularly when compared to the overall NASA budget. It is further true that, if human exploration missions continue to increase in cost, these increases will create the self-fulfilling condition that exploration is not affordable. NASA cost estimation methods (based on data from past and present programs, from the "manned space paradigm") will always lead to the conclusion that we cannot afford to explore space.

However, it is not true that future space missions must continue to be as costly as previous ones, or that exploration of Mars must cost more than the original exploration of the Moon, as was suggested in some earlier NASA studies. NASA is the victim of its own costing techniques, which continue to lie to us: it is possible for missions to Mars to cost hundreds of billions of dollars, simply because, in our lifetimes, there will never be hundreds of billions of dollars to spend on such missions. (And who is interested in things which happen far beyond one's lifetime?) If NASA is to continue to have a human exploration mission, and if the budget cannot be changed, we must change the management paradigm which has caused the costs to be high. By benchmarking world-class high technology programs, it has been proven that costs can be reduced to within available budgets.

The ingredients of successful low-cost, high technology programs are well known and universally recommended by successful program managers interviewed. Some "benchmarking lessons learned" include:

- Use government only to define and verify requirements
- Keep requirements fixed: once requirements are stated, only relax them; never add new ones
- Place product responsibility in a competitive private sector
- Specify end results (performance) of products, not how to achieve the results
- Minimize government involvement (small program offices)
- Insure that all technologies are proven prior to the end of competition
- Utilize the private sector reporting system: reduce or eliminate specific government reports
- Don't start a program until cost estimates and budget availability match
- Minimize or eliminate government imposed changes
- Reduce development time: any program development can be accomplished in 3 to 4 years once uncertainties are resolved
- Force people off of development programs when development is complete
- Incentivize the contractor to keep costs low (as opposed to CPAF, CPFF)
- Use geographic proximity of contractor organizations when possible (e.g., concurrent engineering)
- To reduce the number of interfaces and keep responsibilities clean, use the major prime contractor as the integrating contractor.

NASA has known these principles for many years. Implementation has been difficult.

"Nothing is more difficult to undertake, more perilous to conduct or more uncertain in its outcome, than to take the lead in introducing a new order of things. For the innovator has for enemies all those who have done well under the old, and lukewarm defenders amongst those who may do well under the new."

- Machiavelli

Controlling Costs - The Critical Challenge

by John Hraster
Global Aerospace Science, Goddard Space Flight Center

A recent GAO report said major NASA projects cost an average of 77 percent more than their initial estimates. More than a third cost more than double the estimate. The reasons given were technical problems, budget constraints, redesigns, and other factors. Even allowing for disagreements on the baseline–for example, was the initial estimate a Phase A study or the in-house estimate for the Phase C/D baseline?–this is still a lot of money.

Although it may seem like a cliche, the most important factors in cost control take place before you get into implementation. If the *requirements* are not realistic or well defined, you are automatically set up for problems. They must be minimized to achieve the mission; anything beyond that will add to cost. *Planning* the project involves matching the plan to the requirements and again minimizing when possible. A lean, close knit group is the way to go. A lot of people not only cost a lot but think of other ways to spend money! *Estimating costs* must be done with realism. At this stage it is very easy to forget about the cost of parts qualification, safety requirements that add cost, shipping containers, etc. There is a strong temptation to wish some costs away so as not to endanger a program that is just starting. Don't.

When you reach the implementation phase, the groundwork should have been laid, you've set the requirements, planned the project, and estimated the cost. However, there will be holes, the environment will change, and, above all, there will be problems. How you handle problems with the small amount of discretionary funding you have is the essence of cost control in this phase. Following are a number of shared experiences, thoughts, guidelines, etc., that have worked in the past. The message I want to get across is how important cost control is and how it is woven into the fabric of the project along with all the technical factors.

1. The project manager must be a leader first and manager second. This means staying focused on the goal and making sure everyone else is focused on the same goal. It is often necessary to make tough decisions now that will avoid costs three years from now. Remember, most projects fail because of poor management rather than because of technical problems.

2. It is absolutely necessary to be able to say "no.' This means in all directions; e.g., to Headquarters, to the scientists, to the spacecraft engineers and contractors. Sometimes things look like they can be done for almost nothing–don't believe it.

3. Requirements creep must not be allowed. You're buying the best product for the money, not the best one that money can buy. If you're going to advance the state-of-the-art, do it openly, up-front, with money specified for that purpose, not contingency money.

4. Treat weight, power, and computer memory as resources just like money. These items translate directly into dollars if they get out of control. A strong systems management function is necessary throughout the program to assure requirements are met and don't creep upward.

5. Know what is going on at the contractor's plant. In-plant reps help, but frequent visits by the observatory manager and others are essential. Your team members need to be intimately involved with the work on the floor and make their own assessments of staffing, shifting, schedule, quality, etc.

6. It is essential the project financial manager, observatory manager, and instrument systems manager work very closely with one another. The technical managers must understand how budgets are constructed and contingency funds allocated. The financial manager must know the technical risks, assumptions, and bases of estimate for all in-house estimates. These people should sit down regularly to match the technical and resource requirements.

7. A basic ingredient to successful cost control is a technically strong, self-confident project team. In the best case the contractor will respond with an equally strong team. The desirable result is a mutual respect of the other team's competence, which makes it much easier to reach technical solutions through compromise.

8. Contingency funds are the only discretionary funds you have. They are to be used to cover

problems within the scope of your work, i.e., to meet your basic requirements. They are not meant to cover improvements, new requirements, etc.

9. Do the work as expeditiously as possible. Future work is always more expensive. It is especially expensive if it is delayed from a present plan.

10. If it is necessary to cut back or restructure the program because of severe problems, you can't depend on increased efficiency to solve the problems. Work content must be removed. The amount of money saved by removing work will always be less than it was when the work was put in. Early planning includes preparation of descoping plans that can be implemented if you have serious trouble later.

11. Streamline the interface with the contractor. This is especially true in the reporting area. Have one set of paper do the work of two. For example, if they use a set of charts internally when their subsystem people report monthly to their program office, these can be used as their monthly report to your project office. When possible use the contractor's formats for various reports, including financial and Performance Measurement System reports.

12. It is essential to involve the project scientist, especially in the decision process. He or she is the customer on a science satellite and therefore a stakeholder in project decisions. This person must help make the tough decisions regarding requirements and cost trades, on what is critical and what is not.

13. Trust must be established between the project and the program manager at Headquarters. The program manager should be invited to all key project meetings and must be kept fully informed. This includes an early warning of problems even if they are not yet solved.

14. The award fee process on CPAF contracts must be used effectively. It is effective as a motivator only if it is honest, i.e., a 40 is a 40, a 50 is a 50, and a 90 is a 90. A consistently high score that is not deserved is not a motivator toward better performance, and it will not pass Inspector General scrutiny.

15. Do everything early. Look far ahead. Good planning can help you make informed choices when it is still possible to make them, e.g., a make or buy decision. It can also help you to decide to change a previous decision in time if circumstances have changed.

16. All the principles of TQM are appropriate to the very dynamic environment of project management. By its very nature a project is a team operation and the members must be empowered to do their jobs and challenged to generate ideas to improve the whole operation. There must be a strong interaction between the technical and business people, and between the government and contractors, i.e., no walls.

17. Dispose of problems quickly, both technical and programmatic. Although it is desirable to gather as much information as possible before making some decisions, often that is not possible. Often a non-optimum decision or even a wrong one made in a timely manner is preferrable to a delayed one. A wrong one can be reversed. If one is delayed too long, the worst case is paralysis and nothing gets done.

18. If changes are necessary to the contracted work they should be agreed to and discussed up front with the contractor. There should be no surprises in the change proposals.

19. Communicate! Communicate! Communicate!

20. Take appropriate risk. The operative word is appropriate. Appropriate risk is obviously different for manned and unmanned missions, and for A, B and C class unmanned spacecraft. Good engineering and quality practices must also be used. However, having said all that there is not enough money in any project to cover all risks. Good engineering judgment must be made in many cases when some uncertainty still exists. Look for functional redundancy as well as planned redundancy. Consider other ways of operating rather than building a "perfect" system.

Setting Requirements

A Panel Discussion

Mark Craig led the panel on "Setting Requirements," joined by Glenn E. Cunningham, Project Manager of the Mars Observer mission at the Jet Propulsion Laboratory, Larry Caddy of Marshall Space Flight Center, and David Sudduth from NASA Headquarters.

Mark Craig told the small group that a fundamental problem in setting requirements is a long development time. In fact, he said, "the longer the development time, the greater the cost," and the greater the risk of detrimental external changes, especially from the White House and Congress.

The bottom line, according to Craig, is to establish an effective system engineering process for Phase B. After all, he pointed out, "80 percent of cost is determined by the first 10 percent of decisions." Furthermore, changes in Phase C/D may cost hundreds, even thousands of times more than changes made in Phase B. "Allow no NASA requirement changes once the contract has been set," he advises.

Requirements Tools

by Glenn E. Cunningham
Mars Observer Program

Although sometimes referred to as a necessary evil, requirements are probably a project's most important element. Typically, a manager is the most concerned about cost, schedule and performance; however, the single item which affects all three aspects is the set of a project's requirements. Thus, attention to the setting and maintaining of "good" requirements should be foremost in the project manager's agenda. There are number of tools currently available that aid in the uniform generation, cataloguing, and traceability of requirements.

At JPL we started in the early 80s the in-house development of a requirements capture and hierarchy management tool called TRACER. While we clearly saw the value of the tool, its implementation and acceptance by the project community had mixed results.

As our manager of spacecraft system engineering put it, "We created a germ cell and the antibodies killed it." We designed a tool for the idealized top-down system engineering situation. It captured requirements in a uniform manner, forced quantitativeness, forced the establishment of verification requirements, and provided hierarchical traceables. All the right things. But the problem is–and I suspect that this occurs with most real projects–that we have a lot of bottom-up effects with technology constraints and inheritance constraints. In addition, we found that the people assigned to write requirements were generally more senior, more experienced people who sometimes did not have the computer skills that younger, less experienced people do, and thus we had an acceptance problem in using an automated tool with its attendant structure. We had a user friendliness problem too. Most problems were in penetrating what we call the Level 2 requirements, the mission requirements. It worked better with the hardware requirements, and exceptionally well with the design verification requirements.

But curiously enough, it has been reported that the tool has found good acceptance in the DoD community through distribution by COSMIC. We suspect that this is because there is more formality and structure in DoD's requirements hierarchy than in NASA's.

However, we still believe that automated requirement management through similar types of tools is the way of the future. The key is probably how to apply them. "Faster, better, cheaper" implies less emphasis on "how to do it" than on the top-down "what to do" and thus on requirements that are capability driven. Let the tools evolve their user friendliness, and get the younger, more computer literate people involved.

Planning the Project

A Panel Discussion

Bill Huber of Marshall Space Flight Center led the panel, joined by James P. Murphy, Director of Engineering and Technical Services at Ames Research Center, Thomas E. Huber, Director of Engineering at Goddard Space Flight Center, and Michael R. Luther, Program Manager of the Upper Atmospheric Research Satellite at NASA Headquarters.

Bill Huber spoke on the results of the recent Project Planning Institutional Team, chaired by Jack Lee, designed to reduce both cost and technical risk in new NASA projects. He pointed to inadequate Phase B definition and unrealistic dependence on unproven technology as major cost drivers which can be eliminated or reduced with proper project planning.

Jim Murphy noted that while NASA's technical performance could be rated as "very good," cost and schedule are rated as "poor," mostly of our own doing. "Better planning starts at the top and flows down," he says, defining the slogan of cheaper/better/faster as "do it right the first time."

Two specific areas Murphy chose for comment were major "scope" additions and cost flow-down. The Lee report indicated that the best projects were stable in all key elements of late Phase B/Phase C: science technologies, team members, implementation approach and institutional factors. The "scope" changes causing the worts cost/schedule problems (comparabilein magnitude) were the addition of a major instrument, a complete change of proejct team and implementation plan, and major canges in a parts program. "It takes time to fully understand the cost/schedule results of a major change," he noted.

Murphy also said that the best projects flowed cost requirements to the system and subsystem levels, both at the contractors and NASA. These cost requirements are just as important as the flow-down of technical performance requirements.

Tom Huber described the X-Ray Timing Explorer (XTE) project at Goddard as "a pilot program for new management approaches to enhance productivity that would set examples for other programs." Principles of Total Quality Management were employed on XTE, including common sense management in terms of organizing work, streamlining procedures and communicating; treating the people involved with respect; empowering them to solve problems at the lowest possible level; and preserving those qualities that have made NASA great: a high degree of technical expertise, attention to detail, a thorough test program, professionalism and technical performance.

Cost and schedule would flow from productivity initiatives, especially the following:

- Lead engineers are responsible for technical performance, cost and schedule of their systems (while the project management directorate is responsible for mission and instrument cost, overall schedule control, and project management).
- Cost history is shown on the same charts as schedules, which are part of the technical progress reporting.
- Commonality of design was emphasized by the team in fixed-price hardware, software and data system design.

Early planning on XTE allowed for an efficient parts program, based upon expansion of "standard" parts, thus reducing cost and schedule.

Mike Luther of the Flight Systems Division in the Office of Mission to Planet Earth described the format and content of the Program Commitment Agreement (PCA), "a new way of doing business" at NASA. The PCA is a two-way agreement between the NASA Administration and the program Associate Administrator, who defines the technical and schedule commitments to be accomplished within the annual funding and institutional resources made available by the Administrator. Certain boundary conditions and assumptions are spelled out in the PCA, such as launch and space communications services, specifying both customers and suppliers. The PCA lists all internal agreements (within NASA) necessary to execute the program, and any external agreements with other agencies, Congress or international partners. If a commitment cannot be met, whether technical or schedule, or in terms of resources, the Administrator or the Associate Administrator must notify the other and renegotiate the terms of the PCA.

Estimating Costs

A Panel Discussion

Hum Mandell led the third concurrent panel, with Edwin Dean of Langley Research Center, Dr. Guy Fogleman, Manager of Advanced Programs in the Programs and Flight Missions Branch, Life Sciences Division at NASA Headquarters, and Dave Pine of the Office of the CFO/Comptroller at NASA Headquarters.

"According to our cost models," says Mandell, "we are out of business! Costs are determined by our management paradigm." For him, NASA must reduce the costs of programs to enable space exploration to continue. Low-cost high technology programs are understood by NASA program managers but implementation has been difficult, Mandell says.

He cited four overriding themes in the realm of lessons learned. After compiling many, many lessons learned, Mandell found the following major themes:

Theme 1–The "learning of lessons learned" is not enough in itself to effect a change. There must be a dedicated effort put forth. Some of the quotes of lessons learned under this theme were "change will not happen by itself," "obvious mistakes and weaknesses have been repeated," and "plan the change; a deliberate process of planning is vital."

Theme 2–The way we structure and manage our contracts provides the largest potential leverage for change and management gain within the space cultural paradigm. Some comments under this theme were: "incentivize the contractor to keep costs low," "bidding pressures influence accuracy and risk," "explore fee arrangement to place more emphasis on performance."

Theme 3–The typical NASA bureaucratic management organization, structure, and style does not promote the efficiency and innovation required for successful management. "Lessons" cited were: "establish clear understanding of roles, responsibilities, and authority," "provide open communication in all directions," "motivate all to succeed, " "stress delegation of responsibility," and "(have) flexible organizational structure and management systems."

Theme 4–Programs should begin only when there is a balance between technical content and readiness, schedules, and budget availability and support. The high points listed here were "realistic . . . budgets . . . must be set to avoid wasted management energy," "don't start a program until cost estimates and budget available match," and "ensure all technologies are proven prior to the end of competition."

Cost Trading System (CTS): An Investment in the Future

Presented by Dr. Guy Fogleman
Advanced Programs, Life Sciences Division

In the late 1980s life science projects began changing in response to increased demands for human performance in space. As projects and missions were becoming more robust and complex, they also became expensive and risky, and it became more difficult to defend program costs. Existing cost models were not representative of Life Sciences, and attempts at collecting relevant data for cost modeling were not successful. The lesson for Life Sciences, a lesson that is being learned repeatedly within NASA, is that historical cost data is the key to success in this critical area.

The approach pursued in the development of the CTS was first to place priority on collecting the largest program costs, then eventually to cover the entire life-cycle costs for project and mission activities. Thus, CTS was developed by Guy Fogleman, Joe Fuller (Futron) and Don Strope (Cost, Inc.) in the following order: prime contracts, support service contracts, civil service direct labor and Phase B studies. The expansion of CTS to the later two is currently in process. To the extent possible, CTS relies on the well-understood and utilized WBS and NASA 533 Financial Reporting System to collect costs. WBS end-items and their costs, as well as technical and programmatic data are captured for future application. A program-wide policy is in effect requiring CTS be applied to Life Sciences project/mission procurements greater than $500K. An unplanned result from CTS development has been a greater appreciation by Headquarters and Field Center personnel not only of the value of cost data to the planning of future projects, but also to the management of current ones.

An Agency standard for CSTs could result in benefits similar to those expected by Life Sciences across NASA and the aerospace industry. "Cheaper, faster, better" will require changes in the way we do business and greater investment to obtain those changes. One thing is certain, progress in cost estimation and cost management must occur before NASA can truly claim excellence for its program management. CTS could be the beginning of understanding how to find the common ground that will allow sharing of tools, information and intelligence to advance the state-of-the-art in cost estimation and cost management.

Controlling Costs

A Panel Discussion

John Hraster led the fourth concurrent session on the Cost Control Process. He was joined by Richard A. Austin, Deputy Associate Director for Earth Observing System (EOS) Resources Management at Goddard Space Flight Center, Kenneth A. Sateriale, Procurement Analyst in the Contract Management Division at NASA Headquarters, and Sandra C. Coleman, the Assistant Project Manager and Business Manager of the Space Shuttle Redesigned Solid Rocket Motor project at Marshall Flight Center.

John Hraster showed how cost control is woven into the project along with the technical factors. He noted how there used to be a saying that no project manager would be criticized if the project overran, as long as the mission was technically successful. This is changing, the Agency is changing, the country is changing. The challenge now will be "You've shown us you can do it, now show us you can do it within budget." Or, as Professor K. Pederson of Georgetown said recently, "Reality has now intruded in the space program." Dan Goldin said in a recent interview, "I took a look at the NASA budget, and I was shocked. The run-out was enormous and you know what the amazing thing was? We weren't going to start a significant number of new things–we just had a lot of things in the chute." We need to understand anytime we overrun we take away from a new program that hasn't started. We're not in a position to say, "Well I've done the best I can, but we overran so give me some more money." The answer could well be to descope or cancel.

Ken Sateriale described key points in the new award fee policy. After the approval of the procurement officer, there is no rollover of fee on service contracts, and the fee for non-service contracts is based upon total performance, depending upon the final, comprehensive rating. "Cost control must be emphasized in all evaluations," he said. Performance incentives are required on hardware contacts over $25 million, with a mandatory, uniform, simplified scoring system.

Sandy Coleman reported that three-fourths of NASA contract dollars are presently award fee; this provides the government maximum technical oversight but lends itself to minimum cost control. Prior to Challenger, most Shuttle contracts had been converted to straight incentive structure; this provides opportunities for lowest cost but provides minimum technical control, as was determined to be a flaw by the Challenger Commission. Therefore, all Shuttle contracts were converted back to Award Fee. About two years ago, the incentive contracting approach was revived. Since the RSRM Office was very sensitive to past criticisms of incentivizing cost rather then quality, they devised an award fee/incentive fee structure with a quality gate minimum score required to share in any of the incentive fee pool. This is working to reduce RSRM cost and is consistent with the new initiatives that are being proposed for all NASA contracts.

"Cost control to me means cost reduction," says Coleman, and "the one single greatest contribution you or I can make as an individual in reducing costs is to penetrate every line item in our budget." She also suggests challenging all cost estimates, all "value added" of each activity, to understand cost and to make the contractor self-conscious about every dollar spent. She concludes: "I bet you would be surprised at the contractor reports which never get challenged. I believe we can make a difference by simply penetrating data."

Systems Engineering Steering Group

A Panel Discussion

Bill Morgan of Johnson Space Center led the Systems Engineering Steering Group, accompanied by Dr. Mike Ryschkewitsch, Chief of the Systems Engineering Office at Goddard Space Flight Center, J. Milam Walters who manages the development of a project/engineering database at Langley Research Center for Internet worldwide, and Anthony D. Fragomeni, Associate Chief of the Systems Engineering Office at Goddard.

Bill Morgan presented an overview of current Systems Engineering Steering Group (SESG) activities including the publication of a draft NASA *Systems Engineering Handbook,* edited at the Jet Propulsion Laboratory, and *Readings in Systems Engineering,* edited by Frank Hoban and William Lawbaugh, with preprint copies made available to the participants. Morgan said Systems Engineering Working Groups are being formed at each NASA Center to define and improve the process and methods of systems engineering, integrated tools, career development and communications. In addition, Special Interest Groups are being formed to serve as intercenter product development teams. "NASA today is challenged by increased program complexity and duration, plus reduced resources," says Morgan. To meet theses challenges, we must increase the effectiveness of the Agency by:

- Developing compatibility among the Field Centers' processes for program management, program control and system engineering
- Improving the effectiveness of the civil cervice work force in executing these processes
- Enhancing the workforce collaboration throughout the Agency
- Increasing the future effectiveness by developing a continuous process improvement program.

Tony Fragomeni added "some food for thought." He said: "It is taken as axiom that what has worked well in the past is the best starting point for future improvements. There is a correlation between a fully adequate mission design process and a successful Phase C/D. Phase C/D cost overruns usually occur because of a lack of understanding of requirements, inadequate definition of requirements or changing requirements, both technically and programatically."

Current SESG Activities

System Engineering Working Groups

Process & Methods

- JSC SEIP (Complete)
- MSFC SE Handbook (Complete)
- JPL SE Handbook (Complete)
- GSFC Mission Design Process (Complete)
- SEPIT (In Progress)
- TTPIT (Proposed)
- Continuous Process Improvement (Proposed)
- CE (Requested)

Integrated Tools

- JSC Integrated CASE Environment (Proposed)
- LaRC EDB Prototype (In Progress)
- JPL Tool Summary (Complete)
- JSC Tool Summary (In Progress)

Career Development

- SE&I Career Ladder (In Progress)
- SE&I Curriculum (In Development)
- SE&I (Proposed)
- QFD (In Development)
- DYSE Dynamic System Engineering (Ongoing)
- CSM SE Course (Ongoing)
- Jim French System Engineering Course (Proposed)

Communications

- NASA SE&I Newsletter (Proposed)
- Readings in System Engineering (Ongoing)
- Lessons Learned Data Base (Ongoing)
- SE Bulletin Board (Ongoing)
- SE Symposia (Ongoing)
- SE&I Video Lecture Series (Ongoing)
- SEWG Videocons (Ongoing)

Program Control Steering Group

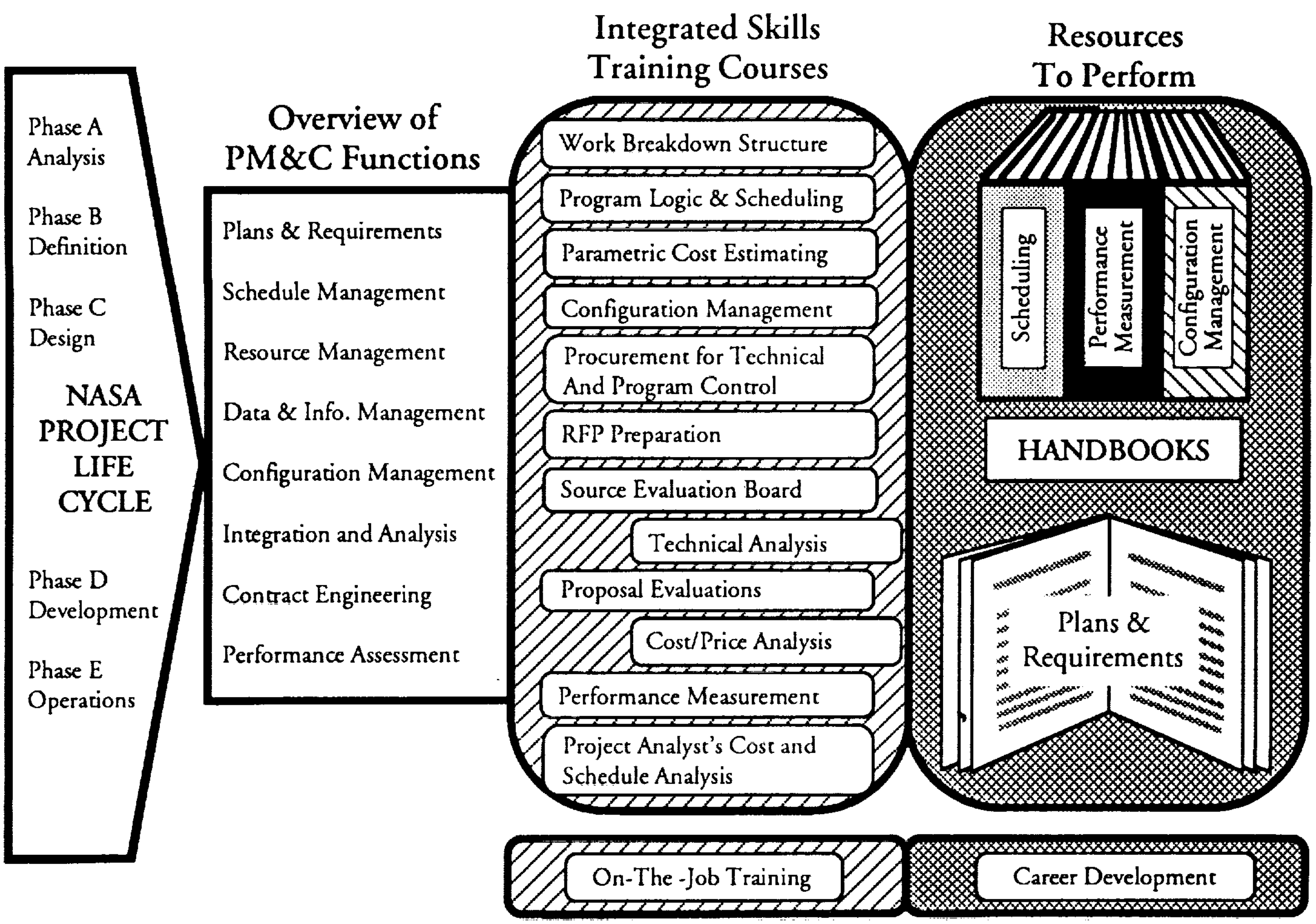
A Panel Discussion

Dave Pine led the Program Control Steering Group presentation, joined by James E. Bone, the Agency-wide integrator for program control improvement, a part of the NASA Program/Project Management Initiative, and Paul A. Mowatt, Deputy Director of the Flight Projects Directorate for planning and business management at the Goddard Space Flight Center.

The panel discussed the program objectives for the program control network: "Strengthen current management and train the next generation of project management personnel in program control subjects."

They plan to accomplish this objective through skill courses, handbooks, and efforts in career planning and development. Their approach is to assign a full-time integrator and involve Center and Headquarters key personnel, such as program control managers and Center comptrollers. NASA experts will be tapped to develop and deliver training materials and incorporate them into Center training programs.

Program/Project Management And Control Life Cycle/Occupational Relationship



Segment: International Cooperation

Roles and Strategies in International Programs

By Peter G. Smith
International Affairs, International Relations Division

More than 1,200 agreements with over 130 countries and international organizations have been negotiated by NASA in the past 30 years. In fact, noted Smith, international cooperation is mandated by the *Space Act of 1958.* The benefits of such cooperation has been monetary (more than $12 billion contributed or pledged), strategic (access to foreign expertise and facilities) and, of course, political. The downsides, however, include management complexity, technical and programmatic risk and, of course, political risks. On balance, NASA programs have been greatly enriched and strengthened with international cooperation, Smith noted.

As far as program and project managers are concerned, Smith urged specific division of responsibility with international partners. Management structure and responsibilities must be made clear from the start, augmented by clear reporting documentation and monitoring.

Help in international expertise, coordination with other agencies and skilled negotiators are readily available to the project manager from the International Relations Division. International Relations is organized by both functional area and major cooperative partner, including special relationships with Russia.

An Overview of NPO Energia/NASA Commercial Relations

by Jeffrey Manber
Energia USA

"Space holds a special place in our psyche," said Manber, who wondered aloud if "aerospace is going the way of steel or autos" in terms of international consortia. "America has lost the soul, the drive to get back to space," Manber asserted, and the motive has instead become mired in litigation. He questioned why NASA does not use the Mir space station, for example. "It does not have to be the pinnacle" of technology and hygiene, "just representative," he said. Finally, in defense of Energia being what NASA may call "a quasi-commercial organization," Manber asked: "How private is the private sector when Rockwell gets most of its dollars from NASA and the U.S. government?"

He added: "The Russians are not going to go away. They're not going to make just toasters and refrigerators . . . It seems very clear that the space industry is going the way of the automobile industry and the steel industry. And it's going to be international. And you'll have 20 percent equity ownership from a XYZ company, and 15 percent from the Russian government, and 18 percent from J.P. Morgan . . .

"Robert Reich, the Secretary of Labor, said recently the very idea of an American economy is becoming meaningless. As are the notions of American corporation, American capital, American products, and American technology.

"And so, you know I would say to you that even though you are all government people, that one of the strongest new commercial markets in the aerospace space arena is in the capabilities of the former Soviet Union. I think that at some point industry is going to be moving in. I think that will give us a more robust capability. It will lower the costs of doing business in space."

International Shared Experiences

Dr. Steven Holt, Director of Space Sciences at Goddard Space Flight Center, led this panel, with Gil Ousley of BDM Federal, Robert McBrayer, Task Team Manager of the Lunar Ultraviolet Telescope Experiment (LUTE) at Marshall Space Flight Center, and Joseph Alexander, Associate Director of Space Sciences at Goddard Space Flight Center.

A Panel Discussion

International Project Management

by Gilbert W. Ousley, Sr.
Former NASA European Representative

The basic bible for a NASA International Project Manager is the Memorandum of Understanding (MOU) or the Letter of Agreement (LOA) that outlines the basic responsibilities of each participant and authorizes the project managers to carry out the execution of these responsibilities. The MOU/LOA is not a contract but an agreement between partners to use their best efforts to conduct their part of the program. This agreement is executed on the basis of no-exchange-of-funds.

The key relationships for the project manager are with the NASA project scientist, the NASA program manager and the co-project manager in the other country. Joint project management is "very much like a marriage" where each partner brings something essential to the combined team, and a successful relationship requires the practices of flexible understanding and patience. Careful recognition and consideration of each partner's contribution must take place continuously (as in a marriage), and a strong feeling of mutual dependence and trust is required to navigate the many difficulties (including cost) jointly affecting both sides in an interdependent manner. Neither project manager should dominate the relationship with a foreign counterpart regardless of the proportions of the individual country's contribution, and persuasion is the preferred tactic of total successes. At the end of a scientifically successful program, each side should be eager to continue the same relationships into future cooperation.

Clear, simple and definable hardware and software interfaces must exist near the beginning of a project, and some means of verification (usually with an engineering model) should be exercised as early as possible in the project's life. A Joint Working Group, co-chaired by the project manager, that meets on a regular/specified schedule (every four or six months) and which produces timely minutes containing discussions, agreements, and action items (with assignees and due dates) is essential. Interactions must be discussed openly and objectively, and resolved in a mutually satisfactory manner. All scientific data should eventually be made available in a form suitable for analysis to the National Science Data Center for distribution to the international science community.

Successful cooperative projects in which the scientific objectives are clearly met in a harmonious, timely and cost effective manner do not just happen; they are made to happen.

International Scientific Payloads

by Robert O. McBrayer
LUTE Task Team Manager, Goddard Space Flight Center

Serving as Assistant Mission Manager for the Spacelab One and Spacelab Three Shuttle/Spacelab International Missions was excellent preparation for assignment as the Mission Manager for the First International Microgravity Laboratory (IML-l) Spacelab/Shuttle Mission. This seven-year project involved NASA and other international space agencies, over 200 science investigators from 14 countries, and over 42 different investigations.

As Mission Manager of the IML-l Mission, I have had to deal with continual pressure to minimize the cost increases associated with Shuttle manifest changes, continually balancing budget, schedule, technical complexity and the scientific requirements and desires of the scientific community, while interacting with five other NASA Centers and five international space agencies. A Letter of Agreement was signed by International Relations and identified the program managers and the program scientists for each Agency (i.e., NASA and ESA). This Letter of Agreement established the conditions of participation for the foreign partner and the specific duties of each Agency. For IML-l, NASA provided the flight opportunity for a foreign partner's hardware developers and science investigators in exchange for use of their apparatus, or data, by U.S. investigators. The Letter of Agreement established a framework for the development of a detailed interface agreement between the experiment developer and mission management. The mission manager then utilized existing mission documentation (i.e., Instrument Interface Agreement and Operations and Integration Agreement) to establish requirements for the integration of each experiment into the IML-l payload.

Interaction with foreign partners (management, scientists, and experiment developers) on IML-l was an extremely positive experience. International cooperation dictates the understanding of other cultures and sensitivity to communications. A good understanding of the schedule, technical and resource interfaces is a necessity for communicating with the language and cultural challenges facing personnel on both sides. Straightforward relationships were a key aspect of successful interaction with the foreign partners on IML-l. These same principles can be equally applied to interaction with any partner, foreign or domestic, on any project. There is no real substitute for a clear, unambiguous planning, understanding of the other partners' constraints and needs, and straightforward relationships in any successful program or project.

Segment: Agency Relations

Conference attendees were invited to participate in two concurrent panels on Agency Relations. Dr. Scott Pace led the panel on Inter-Agency Cooperation, with Dr. Fenton Carey from the U.S. Department of Energy, Beth Masters from the U.S. Department of Defense and Tyrone C. Taylor of the Policy Coordination Division in the NASA Office of Policy Coordination and International Relations.

Kathryn Schmoll led the panel on Intra-Agency Cooperation with Vernon Weyers, Director of Flight Projects at Goddard Space Flight Center, George Levin, Chief of Advanced Systems in the Office of Space System Development at NASA Headquarters, and Thomas H. Cochran, Director of Space Flight Systems at Lewis Research Center.

Inter-Agency Relations

by Dr. Scott Pace
Office of Space Commerce, Department of Commerce

Some of you here today may find yourselves in inter-agency negotiations or trying to understand the negotiation process. The Office of Space Commerce is responsible for policy coordination on all space-related issues and activities in the Department of Commerce. The Department is not a "space" agency the way NASA is; rather it is like the Department of Defense in that many of its activities are dependent on space systems or they impact the space activities of others. NOAA operates weather satellites, the Bureau of Export Administration regulates the export of some space technologies, the International Trade Administration promotes trade in space goods and services, and the National Telecommunications and Information agency influences international telecommunications policy and spectrum allocations.

Space, more than other issues, tends to cut across traditional agency boundaries. One of the useful results of the Space Council has been the creation of good working relations, and sometimes personal friendships, among the agency representatives. How will space policy issues and those inter-agency relations fare now that the Council has been eliminated (again)? Non-military space issues have been nominally sent to the Office of Science and Technology Policy (OSTP), yet space issues are not just technology-related. The National Economic Council (NEC) and the National Security Council (NSC) both have equities at stake in many space issues. OSTP and the NSC may extend themselves into economic issues or there may be ad hoc blends of these White House organizations as specific space topics arise.

The demise of the National Space Council signals an interest by the new Administration in folding space into broader science and technology themes and not focusing on it as a separate, special entity as it has been since Sputnik. This reflects a number of forces such as the end of the Cold War, the integration of space activities into many routine civil, military, and commercial activities, and the need to ensure U.S. government support of science and technology is rationally integrated with other national interests. These forces are likely to make inter-agency cooperation and competition more important than ever. Agencies may find themselves having to work out things on their own more without a White House space staffer forcing an agreement.

If inter-agency negotiations are done well and in ways that find creative solutions to conflicts, the agencies participating can look strong and competent. If negotiations are done poorly, agencies can look weak, incompetent, or at best narrow-minded. None of these perceptions is likely to be helpful in winning support from the White House, Congress, the American people, or other countries. Successful inter-agency negotiation is more than just being "tough," but requires a blend of many skills, knowing when to be confrontational (rarely), when and how to compromise, and when not to say or do anything at all. As told to me by one experienced agency representative: "Do you want to score points or do you want to win? The two are not the same." Success means having agency leaders and managers thinking clearly about goals and strategies. For the project manager trying to navigate in a world very different from Apollo, it means deciding if you want to be an agent of positive change or irrelevant.

In politics, it is often said that timing is everything. Thus one of the most subtle questions is knowing when to engage in inter-agency negotiations and when not to. In the past, there have been reviews of virtually every major space policy topic, such as the future of space transportation, the Landsat program, and procurement reform. In my own experience, space transportation and international cooperation have been two themes that seem to come up the most often.

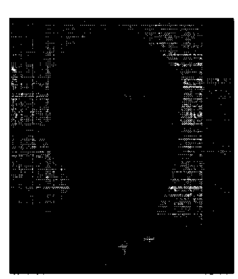
In the future, there will be inter-agency discussions of global environmental monitoring dealing with national security, economic, and foreign policy issues that go beyond the scientific questions. I expect there to be a greater emphasis on integrating space technology issues into the broader technology policy of this Administration and finding more opportunities for commercial applications. Aeronautics is slated for increased emphasis, and NASA's past efforts in this area are often cited as a model of what might be done with other industries, both inside and outside of the traditional aerospace community.

It should come as no surprise that the drivers for space policy today are limited government budgets, the defense draw-down conversion and the need for stronger economic growth. Space projects will find themselves facing increasingly stiff criteria not only in terms of how scientifically productive they are, but how they contribute to the technical and managerial strength of U.S. industry. In a period of budgetary stagnation or even reductions, I would urge caution in pulling work in-house. Government needs industry as a partner, not just as a contractor, and that means sharing the pain of reductions while looking for new cooperative opportunities.

Inter-agency negotiations will play a significant role in structuring space policies and budget priorities that fit today's realities. NASA managers will therefore need to learn how to anticipate the needs and outcomes of these negotiations. This means thinking beyond traditional NASA communities in the search for allies and supporters. The very successful manager will likely be the one who has a vision of how to meet the needs of more than one agency and is able to use inter-agency agreements to reinforce the objectives of his or her program.

Some of you may find yourselves in inter-agency negotiations or trying to understand the negotiation process. If so, I have some personal suggestions that hopefully may make you more effective. However, I do not make any claim to having followed my own advice.

- The first rule of diplomacy is to maintain friendly, respectful relations and open lines of communication with all parties. Make courtesy calls to introduce yourself.
- The signal-to-noise ratio in policy debates is very low. Try to stick to a few, simple principles in articulating why you support a position. Try to be clear about what conditions could cause you to change your position.
- Look for leverage points in creating coalitions with other agencies, such as budget concerns or complementary missions. Establish internal and external stockholders in policy so that implementation happens; do not rely on top-down directives.
- Support studies that look ahead to future scenarios and try to map out alternative scenarios for how budgets, international relations and technology may develop. Remember the importance of fairness and credibility, especially if you are leading a negotiation. A perception of unfairness is what often leads to press leaks, Congressional inquiries, and even legal action. Above all, you must know what your principals will or cannot support and how far they will go. This means knowing the constituency for your agency and not exposing your principal (i.e., saying he or she will support some action) unless you have clearance to do so. High-level meetings are not the best places to have surprises and free-ranging arguments. Have those discussions off-line and be able to predict what other agencies will say before the big meetings happen.



Dr. Scott Pace is the Senior Technical and Policy Analyst for the space issues in the Office of the Deputy Secretary of Commerce. He represents the Department in inter-agency working groups and advisory committees on civil, military and commercial space matters.

Intra-Agency Relations

by Thomas H. Cochran
Space Flight Systems, Lewis Research Center

In September of last year NASA took the first step in returning the U.S. to the planet Mars since 1975 when the Viking Spacecraft landed on the barren planet. A Titan III rocket launched the Mars Observer Spacecraft together with its upper stage, the Transfer Orbit Stage, called TOS, from the Kennedy Space Center. The launch culminated an intense development effort for the spacecraft as well as the TOS that took five years to complete. Numerous problems were overcome in the spacecraft instruments, the checkout of the TOS at the Cape, and the processing of the spacecraft. On top of all this, the launch was the first to occur at Launch Complex 40, a facility that was completely rebuilt in the span of just two years. Here are the major players involved, including NASA, other Government agencies, and those from private industry who worked on the project.

Within NASA:

- JPL managed the spacecraft development–Marshall managed the development of the TOS
- Lewis managed the Titan III commercial launch services and the integration of the stack on the pad
- Kennedy oversaw the ground processing and launch of the integrated vehicle
- NASA Headquarters, Code S, managed and advocated both the Spacecraft and Launch Vehicle

Other Government members of the team:

- Air Force Division managed the reconstruction of Launch Complex 40
- The Air Force at Cape Canaveral provided processing and launch facilities, safety support and weather support

Private industry participants:

- General Electric developed the spacecraft
- Martin Marietta developed the TOS and provided the Titan III launch services
- Orbital Sciences managed the TOS development at Martin Marietta
- Bechtel constructed Launch Complex 40

The question we have to ask today, "What can we do to improve our relationships even further?" The following suggestions encourage discussion:

First, Centers need to concentrate on working on those things they do best, fine tuning their already considerable skills to be the best there are. Strategies to "cover the waterfront" and to invest in marginal areas on the margin and which cause conflicts with other organizations should be stopped.

Second, explore the value of personnel exchanges between Centers for periods up to a year. A Center Professional Development Program would permit personal relationships to be developed that would in turn improve communications and break down "ignorance" barriers.

Third, sister Center managers needs to engage in "Information Exchanges" on a regular basis. Structured home and away "Love Ins" and/or videocons that concentrate on areas of common interest, as well as contention, could result in agreements that enhance each Center's ability to accomplish its role as well as clear the air.

And finally, Centers need to develop strategic alliances with other Centers to both supplement and complement capabilities in program areas of common interest. These agreements need to be formal, reviewed on a regular basis, serve as the basis for common technical progress review, and forged by each Center's Senior Management Council.

In conclusion, what the future holds for the NASA community can at best be described today as uncertain. The changes that have occurred in the world militarily and economically will have a profound impact on what we do and how we do it. Make no mistake, things are going to change. As a group we have the power through our varied and immense talents and the tools we have at our disposal to have a significant impact on the future of this country. However, this will only happen if we put aside our parochial interests and utilize the teams and cooperation we have demonstrated to be so powerful.

Segment: Industry, Government and University Partnerships

Commercializing U.S. Technology

by John Preston
Technology Licensing, Massachusetts Institute of Technology

Universities in the U.S. have a significant impact on business through the transfer of technology. This transfer takes various forms, including faculty communications (such as lecturing and publishing of research results), faculty consulting activities, and the direct transfer of technology through the licensing of patents, copyrights and other intellectual property to industry.

Well-trained students and professional staff who leave the university to work in industry probably represent the universities' greatest transfer of technology. These persons stimulate creativity and bring new ideas and perspectives to industry.

Perhaps the most dramatic form of technology transfer from universities is the creation of new businesses. A 1988 study of MIT spinoff companies by the Bank of Boston revealed that its personnel and technology were involved in 636 companies located in Massachusetts. In 1988, these companies employed over 20,000 Massachusetts residents, with annual revenues of $39.7 billion. Had all of these revenues been within Massachusetts, it would have amounted to about one-third of the Commonwealth's economy. A 1989 study by Chase Manhattan Bank identified 225 MIT spin-off companies in Silicon Valley with annual revenues of over $22 billion. A study of Stanford spinoff companies would probably show similarly impressive economic impact.

Regional economies receive a double benefit from these high tech, spinoff companies. Several studies have indicated that for every high technology job created, four or five low tech jobs (retailing, government, hotels, construction . . .) are also created.

Companies founded by MIT people include Digital Equipment, Raytheon, Analog Devices, Lotus Development, Intel, Genentech and several other large businesses. Many MIT spinoff companies achieve tremendous growth rates. Such companies are often characterized by the following: seed financial investment secured from a quality source of capital; talented entrepreneurs with diverse and complementary management backgrounds; and a core technology with broad applicability, numerous products, and considerable growth potential. These companies seem to play an enormous role in stimulating the economy and creating jobs.

International competitive factors are forcing America to wake up to the importance of encouraging technology transfer and the creation of high tech companies. The U.S. spends more on research and development than any other country. In fact, its research expenditures are roughly equal to the combined research of Japan, Germany, the United Kingdom and France. The U.S. Government has recognized the importance of domestically capturing the value added of our research, and numerous laws have been passed that streamline technology transfer. The net effect is that there has been enormous growth in formalized technology transfer from U.S. research institutions to industry in the last five years. Universities and government laboratories have become much more aggressive in finding mechanisms to get their technology commercialized, no longer relying only on publishing research results and transferring trained people.

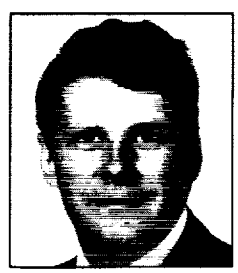
The passion of various players is the key determinant of success. Worded differently, any new business will encounter hundreds of barriers before it succeeds. People with no passion will use the first barrier as excuse for failure, while people with high passion will do whatever it takes to overcome the barriers.

There are many ways to kill the passion, but greed takes first place. "Greed" in the form of equity distribution is probably the single largest barrier to creating companies. All players in a new company are trying to maximize their ownership. Often investors feel they should own 100 percent of the company. These people push very hard for a high stock price when they raise venture capital. This behavior typically drives them to raise money from secondary sources (relatives, wealthy friends or unsophisticated investors). This lowers the quality of the investor. Second, very stingy incentive stock plans for their employees again attract second-rate players. Worse yet, in addition to getting second-rate employees and investors, the passion of the employees and investors fades rapidly as they come to realize that the probability is small that they will make significant money from the overvalued stock they acquired. This means the employees will be unwilling to work long, hard hours and the investors will not be willing to come forward when (not *if*) the company needs more money.

Greed can take many other forms. Within a large company, equity is not the primary motivator because it is much less likely to make significant gains. However, credit for good performance is a key incentive. Managers who claim all the credit when anything good happens and dodge the blame when problems arise are killing the passion of the employees under them.

Other killers of passion include destructive criticism. Many groups of individuals are dedicated to criticizing plans to prevent mistakes. For example, the Food and Drug Administration is designed more to prevent a drug which does not perform to standards from reaching the general public than to facilitate getting new helpful drugs to market. Within companies, committees and lawyers provide the watchdog function. These people serve an important function much like the brakes on your car, but often can have devastating effects on the early stages of any new business development. The psychology of these individuals is that when their advice is sought over some new business idea they can only take credit for "preventing a negative event" rather than "facilitating a positive." Worded differently, they cannot take credit for the original idea, only finding its problems. A large dose of criticism kills passion.

Start-up companies and technology transfer to existing companies will continue to play a major role in economic development. The positive impact from new business creation can be increased by targeting appropriate technologies; finding strong managers and quality investors or sponsors; enhancing the image or credibility of the business; and finally encouraging passionate behavior by the key players toward the success of the new business. These qualities, coupled with a well written, balanced agreement and good will on the part of both the licensee and licensor, will greatly enhance the likelihood for success of the venture and rewards to the licensor.



John T. Preston is the Director of Technology Development at the Massachusetts Institute of Technology (MIT). As Director, he manages the Technology Licensing Office, which is responsible for patenting licensing of MIT Lincoln Laboratory and Whitehead Institute inventions and software.

Technology Transfer: A NASA Model

Kevin Barquinero, Director of the Space Commerce Opportunities Office, was joined by Carol A. Ginty of Lewis Research Center, who recently served on the Agency Special Initiative Team on Technology Transfer; Judith Watson, a research engineer in the Spacecraft Structures Branch at Langley Research Center; and Jonathan Root from the Office of Advanced Concepts and Technology at Headquarters.

A Panel Discussion

Commercializing NASA Technology

by Kevin Barquinero
Space Commerce Opportunities Office

Value-added facilitators for targeted technology transfer is an experiment at NASA to accelerate commercialization of NASA-developed technology. The hypothesis is that by bringing commercialization expertise directly to NASA technologists, the probability of successful technology transfer will be increased. Two new NASA activities–the Joint Space Center and Ames Research Center–taken together, test the value-added facilitator hypothesis.

The phrase "targeted technology transfer" was coined by Dr. Jerry Creedon of Langley Research Center and his Special Initiatives Team on Technology Transfer, chartered by NASA Administrator Daniel Goldin in May 1992. The team was tasked to review and make recommendations for improving NASA's process to transfer and commercialize its aeronautics and space technology. Their report to the Administrator in December 1992 identified *non-targeted* and *targeted* technology transfer activities.

Targeted technology transfer involves NASA's conscious involvement to collaborate with industry to commercialize its technology. The team broke down this category into two subcategories: primary and secondary targeted technology transfer. Primary targeted technology transfer occurs when "the technology is part of NASA's primary mission and is developed from the outset with the purpose in mind of transferring it to an identified aerospace user." NASA's entire aeronautics program represents this category. Newer programs, like the Centers for the Commercial Development of Space, are examples from the Agency's space program.

Secondary targeted technology transfer refers to "technology originally developed for a NASA mission extended by NASA to meet the identified needs of a specific user for a non-aerospace application." The committee noted that NASA dedicates very little effort or resources to this category, although it is this area, the broader U.S. economy, that offers greater opportunity for transfer of NASA technology. This is the only area where the Creedon Committee recommended that NASA increase its budget.

The Creedon Committee report is important because it affirms the need for NASA to be more active in its efforts to transfer its technology. The challenge facing NASA is how to accomplish this mission when its vast technical talents lie in developing technology for its aeronautics and space missions–not in collaborating with industry to commercialize this technology. This is a knowledge gap that thwarts the Agency's best intentions to transfer technology. The premise behind using facilitators is that they fill the knowledge gap between NASA's technology and the know-how needed to target the technology's transfer to industry.

It is possible to compress the time for technology commercialization from a NASA Field Center through employment of value-added facilitators. The facilitator's unique expertise should accelerate the process of technology transfer and commercialization, promote dual-use technology development, and contribute to national and regional economic competitiveness. The metrics for success are: leveraged economic development, technology transfer to existing companies, technology transfer to new firms, and knowledge transfer. If pilot programs are successful, NASA will transform itself from its past role as a civilian fixture of the Cold War to a national technological engine for economic growth through the accomplishments of its aeronautics and space missions.

Creedon Commission Recommendations

by Carol Ginty
Special Initiative Team on Technology Transfer

One member of the Creedon Commission, Carol Ginty, elaborated on the findings that current and existing "technology transfer processes are non-integrated, undocumented, and too slow." She presented ten recommendations designed to improve NASA's technology transfer performance:

All NASA elements must implement and be evaluated on their technology transfer program.

1. Each Center must manage to the recommended metrics or define and manage to a more effective set.

2. Headquarters must implement a unified plan to support technology transfer, e.g., provide infrastructure activites supporting all Centers, and institute a proactive effort to change the agency's technology transfer culture and ensure broader participation by all employees.

3. NASA should specifically mention technology transfer in Vision-Mission-Values statements.

4. The Administrator should send a directive to Associate Administrators and Center Directors stating that technology transfer is a mission of NASA and specifically, that secondary targeted and non-targeted transfers are fully valued, important NASA missions which should be managed accordingly.

5. The Administrator should continue strong technology transfer support and measure overall agency performance.

6. Each Center should include technology transfer in its mission statement.

7. Each Center should provide technology transfer training for its employees.

8. Assess, promote and reward employees according to metrics/contributions.

9. Form and empower at least the following process action and process development teams

   - Tech Briefs–information acquisition to publication
   - Patent applications and licensing
   - Software distribution and transfer
   - Conversion of non-targeted to secondary targeted
   - Conversion/integration of primary targeted to secondary targeted
   - Execution of secondary targeted programs
   - Use of jointly sponsored research activities
   - Define relationship of Centers to CCDS
   - Employee motivation and incentive for technology transfer activities.

10. Secondary technology transfer activities should be proactively sought. The budget allocated to each Center for its use in secondary targeted transfer programs should grow and be taken "off the top" as is SBIR.

Continuing improvements must be made in NASA's technology transfer performance for NASA to best serve the country. NASA's culture must change to achieve continuous improvement in technology transfer. Implementing the ten recommendations constitutes an important first step in improving NASA's technology transfer performance.

NASA's Development of the National Technology Transfer Network

Presented by Jonathan Root
Office of Aeronautices and Space Technology

Jonathan Root outlined selected elements of the Clinton Administration's technology policy, described as a flexible, market-oriented means of advancing U.S. economic growth and industrial competitiveness.

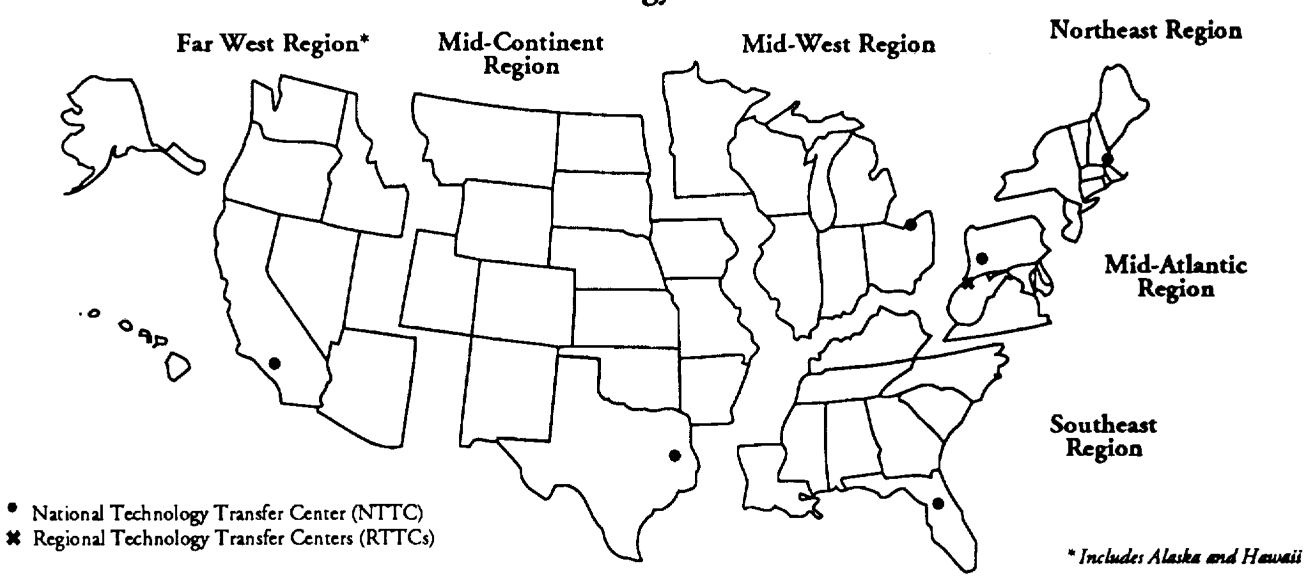
Abroad, consensus among government and industry leaders has developed over the last decade on the importance of applying U.S. leadership in research and development to enhance and promote U.S. economic growth and industrial competitiveness in the global marketplace. This commitment is further strengthened by the President's Technology Policy, which calls for improved strategies for leveraging the federal research and development investment, involving over 700 laboratories, through government/industry cooperation in support of industrial technology.

In recognition of this challenge, the NASA Technology Transfer Program initiated in 1991 the development of the National Technology Transfer Network (NTTN), in cooperation with other Federal agencies. Under NASA's leadership, six Regional Technology Transfer Centers (RTTCs) and the National Technology Transfer Center (NTTC) currently operate as the core elements of this innovative national network. The NTTN serves as a market-driven means of facilitating government/industry technology partnerships and the transfer of Federally funded technology to the marketplace.

Driven by the pressures of economic competition, and, more recently, by the defense downsizing, NASA management recognized that the new environment offered unprecedented opportunities for collaboration between industry, state programs, and Federal research and development agencies and their technology transfer programs and labs. Accordingly, the RTTCs and the NTTC were concurrently designed and developed to form the core structure of a national network, linking together federal and state programs and resources to address the technology and related needs of industry.

The implementation of the national network began in January 1992 with the start-up of RTTC operations in six regions spanning the U.S. The regional deployment has allowed the RTTCs to establish innovative linkages and partnerships with a wide range of Federal labs and state-level programs, along with the regional organizations of the Federal Laboratory Consortium for Technology Transfer. The RTTCs draw upon their regional networks and other elements of the national network to serve the technology and related business needs of U.S. firms and industry groups. The RTTCs assist industry clients to access and commercialize technologies developed by NASA and other agencies, and to form technology partnerships with NASA Centers and other Federal labs. The RTTCs' market orientation and knowledge of industry needs also

National Technology Transfer Network



"Techology . . . from the lab to the marketplace"

enables them to assist Federal labs to locate industry partners and market their technologies for commercial use. In their first year of operation, the RTTCs provided services to over 2,500 industry clients. Call 1-800-472-6785 to contact the RTTC in your region.

At the direction of Congress, NASA initiated in 1991 the development of the NTTC to assist and enhance the technology transfer efforts of all Federal agencies. Thus, NASA was uniquely positioned to integrate the NTTC with the RTTCs to form the basis for the national network. Planning for the center resulted in the NTTC serving as the national "hub" for the network, providing core capabilities and services in several key areas. For example, the NTTC operates a national gateway service that assists U.S. firms to rapidly locate federal laboratory technology and associated technology transfer assistance. The NTTC gateway service, which began in October 1992, currently handles between 200 to 300 technical inquiries from industry per month. Other key NTTC activities include technology transfer training and education services; outreach to industry to promote federal technology transfer; and other initiatives to stimulate private/public technology partnerships with Federal labs and further develop the national network. Call 1-800-678-NTTC to contact the national center.

Overall, the NTTC, the RTTCs and their affiliated Federal and state programs provide a national framework for the public and private sectors to work together to leverage the federal Research and Development budget for commercial purposes and advance U.S. economic growth.

Findings of the NASA Technology Integration Review Team

by Judith Watson
Spacecraft Structures Branch, Langley Research Center

The Technology Integration Team was established in May 1992 as a NASA institutional team commissioned to assess present requirements and approaches for achieving the integration of state-of-the-art technology into NASA programs, and to develop recommendations to improve current practices and processes for identifying, developing, and integrating technology into NASA programs. This inter-Center team is chaired by Dr. J. Wayne Littles, Deputy Director of the Marshall Space Flight Center.

The team gathered data from a wide spectrum on pertinent sources including NASA Headquarters program offices, technologists from three NASA Centers, NASA project managers, industry, OAST space technology red and blue teams, the OAST Technology Integration Study, and the Technology Transfer Institutional Team. The Technology Integration Team found that the agency lacks a consistent vision to which technology research and development can be directed for successful integration into NASA programs. Consequently, the Team offered the following recommendations.

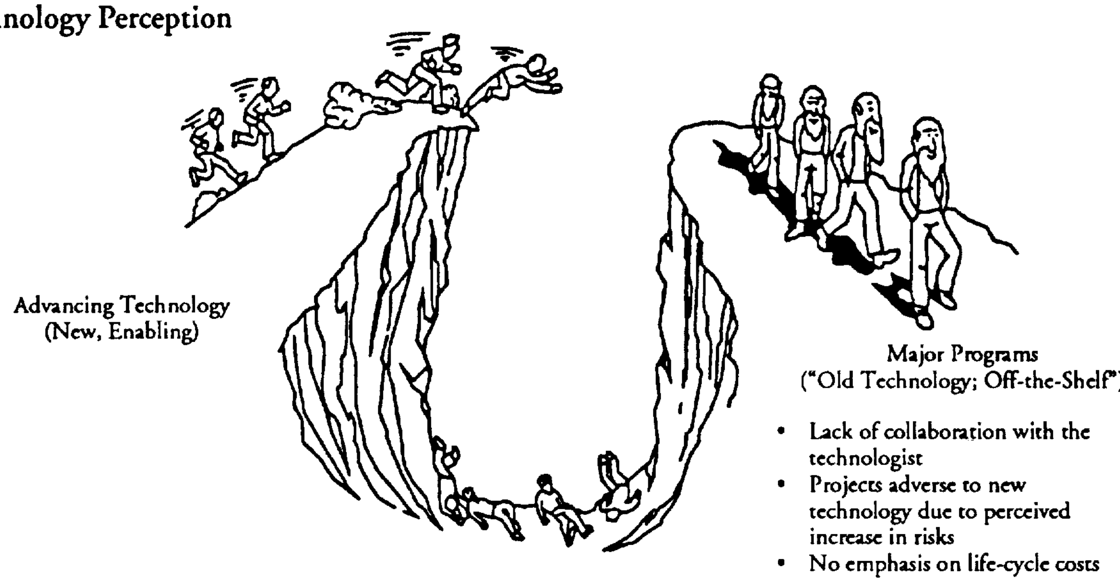
NASA:

- Should develop a nationally accepted vision and strategy in sufficient depth to provide guidance for identification and development of required technologies. The development, use and transfer of technology should be a mission of the Agency.

- Investment in technology (approximately 30 percent) should be doubled during the next three years, with two-thirds of the increase devoted to Advanced Technology Development and one-third to Research and Technology.

- Should shift its emphasis from controlling initial development costs to maximizing cost effectiveness over the life of its programs. Life cycle cost

Technology Perception

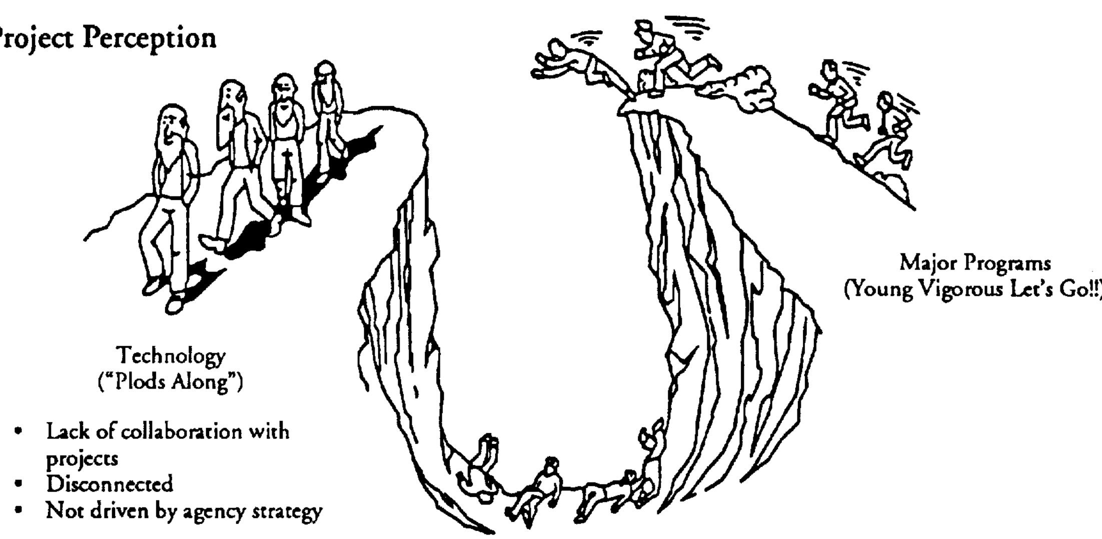


should be an integral part of the phased development process. In addition, the Agency's technology development programs should address life cycle cost as well as performance factors.

- Should implement a phased development process which includes the early identification of requirements, early identification of technology options in collaboration with technologists, and the maturation and selection of technologies prior to phase C/D.
- The Agency should establish a process to enable its many organizations to work as a system in identifying, developing, and integrating technology into its programs. Agency investments in base research and focused technology programs and in advanced technology development must be based on Agency prioritized needs and potential benefits.

These findings and recommendations are available in more detail in the team's final report, *Assessment of Current Processes for Integration of Technology into NASA's Space Programs.* Also, as part of the team's recommendations, an NMI is has been developed and is currently under review, which should improve NASA technology development planning.

Program/Project Perception



Commercialization and Dual Use Technologies

The other concurrent Industry, Government and University Partnership panel was devoted to "Commercialization and Dual Use Technologies," led by William J. Huffstettler, Manager, New Initiatives Office at Johnson Space Center. He was joined by Dr. Syed Shariq, Assistant to the Deputy Director, Science and Technology at Ames Research Center; and Dr. Molly K. Macauley, a Fellow at Resources for the Future.

Dr. Shariq was also a member of the Creedon Commission and he presented an overview of their findings on technology transfer, especially the finding that there is "no clear NASA policy for technology transfer." As a result of legislation passed in the 1980s, NASA is being held accountable for its performance under the standards set in recent and emerging technology transfer statutes.

A Panel Discussion

NASA's EOCAP Program

by Dr. Molly K. Macauley
Senior Fellow, Resources for the Future

NASA's Earth Observations Commercialization Applications Program (EOCAP) was established upon recommendation from a 1986 report by NASA's Space Application Advisory Committee, *Linking Remote-Sensing Technology and Global Needs: A Strategic Vision.* The program is intended to encourage U.S. industry jointly to find NASA remote sensing research that had commercial potential. A key assumption is that NASA technology beyond the "proof-of-concept" stage can readily become commercially profitable.

The first phase of EOCAP, EOCAP I, involved nine commercial projects each competitively awarded between $100,000 to $500,000 annually for up to the three-year duration of the program (1988-1990). Awards for EOCAP II, involving 11 projects and federal funds totaling about $6 million, were made in 1991. In both EOCAP I and II, co-funding by industry partners has roughly matched the level of Federal funding.

EOCAP has been carefully designed to limit government's role in a commercial activity to those aspects of the activity where the private market, operating on its own, might fail. Specifically, EOCAP serves to provide financial and technical support for a limited time and in areas where markets might fail because of gaps between science or technology and commercial markets. Extensive oversight of the program included periodic reviews using several criteria to measure success. These criteria include:

- Net commercial profitability and/or net public benefit;
- Development of new product lines with verifiable customer willingness to pay;
- Reportable innovations that improve the efficiency of relevant markets (for example, standards for data format, developments in iconography); and
- Lessons for public policy (when the lessons are seen as uniquely provided by the EOCAP experience).

These criteria implicitly admit that even "money losers" can be successful in some dimensions–profitability may come later, beyond EOCAP, in the case of the first item above, or some contribution can be made in terms of innovations that improve the functioning of remote sensing markets. And, of course, lessons can be learned in ascertaining why projects failed to be successful in any of these dimensions, contributing to measurable improvements in future EOCAP activities.

EOCAP's performance for it first two years included $5.3 million in gross revenue and $700,000 in net revenue, for about an 8 percent return on NASA plus industry investment, a return consistent with commercial market rates of interest during this period.

What You've Always Known About Project Management . . . but Been Afraid to Task

by Bill Sims
Walt Disney Imagineering

Bill Sims, a Disney project manager in charge of "creating the world's best theme parks on time and on budget, and having fun doing it," described the construction of the EuroDisney theme park in France. The $1.8 billion project on 5,000 acres with seven hotels opened on time and under budget the previous April.

As a preface to his main remarks, Sims spoke on the vital importance of leadership. "Success or failure comes down to having the right people," he said. "Your job is to tell them exactly what to do and give them the authority and tools to do it." He added that leaders also need "passion," which is sometimes known as motivation.

Sims flashed nearly 50 viewgraphs to illustrate his main points of planning, organizing, coordinating, directing and controlling the project. A project life cycle guidebook will lead to mediocrity, he said, recommending a detailed custom plan instead. "Don't worship process," he said. Instead of following an elaborate organization chart, Sims recommends collaboration plus deliberate tension between functional groups and operational groups for checks and balance. His synonym for coordinating is "courtesy," directing means doing, and a better word for controlling is "prediction" so as not to look back on a project. "No risks, no glory," he reminded the conference attendees, suggesting that schedule is also a control document.

In an ample question and answer period, Sims offered attendees a rare glimpse inside a rather private organization. He said Walt Disney Imagineering entered the computer age only three years earlier. "We are pretty conventional," he said, "not leading edge." The organization also seems to hold on to some rather old fashioned values such as honesty and fairness. In building EuroDisney, for example, the organization refused to buy into "the kickback culture" but attracted decent European contractors who knew the American group was fair. The organization is also reminiscent of an older, collegial, collaborative management climate in which everyone is on a first-name basis. Finally, Walt Disney Imagineering writes a new vision (mission) statement each year. This year it contains words like "passion" and integrity.

The former Air Force official, who has been with Disney for four years, says he is "basically a cheerleader." He will push, challenge, enable and assist his project team, getting obstacles and blockades out of their way. "It's amazing what you can do if you don't care who gets the credit," he concluded.

Resources

Provided by the Code FT Program/Project Management Librarian at NASA Headquarters Library

Vision and Strategic Planning

Some of the following authors will tell you that organizational planning of any kind is most successful when a vision is in place first. Definitions of vision vary, but in Charles Handy's *The Age of Unreason* there is the following:

> A vision has to "reframe" the known scene, to reconceptualize the obvious, connect the previously unconnected dream.

Others may prefer the term mission, but rather than getting bogged down in semantic discussion of vision and mission in this short introduction, both may be seen as goals that unite an organization and help create a plan for the future that can inspire and put all staff members on the same wavelength. Reading the listed books and articles will illustrate more clearly the differences between vision and mission, as well as their potential impact upon strategic planning.

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It can also be called downsizing or rightsizing, cost containment or cost reduction; doing more with less has different meanings and involves different processes. The most relevant meaning to NASA may be doing more (or at least the same) with less funding. Reducing costs, in general, involves at least two kinds of costs: the cost of bureaucracy and the cost of not being entrepreneurial enough. NASA costs also include operational and development costs.

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> The program management element responsible for providing program plans and schedules; schedule visibility and control; and detailed support in the areas of performance, cost, and schedule status.

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